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THE ACCURACY OF AUSTRALIAN AND EUROPEAN CULVERT WEIGH-IN MOTION SYSTEMS

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The Accuracy of Australian and European Culvert Weigh-in-Motion Systems

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Abstract: The concept of using culverts to weigh trucks traveling at highway speed is described and the history of its development in Australia **and** Europe outlined. A theoretical study of the sensitivity of results to data inaccuracy is described for the European system. Results from Australian tests on a range of different types of weigh-in-motion system are reported. Long term variations in axle weight results are presented. Finally, the sensitivity of results to the speed of the vehicle and the implications of vehicle and bridge dynamics are discussed.

1. INTRODUCTION

Bridge weigh-in-motion (WIM) systems were initially developed in the U.S.A. during the 1970's by Moses (1). During the 1980's another system was independently developed by Main Roads, Western Australia (2). In the early 1990's research began at Trinity College Dublin, Ireland to develop a bridge WlM system (3) and this is now currently in use on a number of experimental projects. Both the American and Australian systems have been used for commercial applications on bridges and culverts.

The accuracy of the European system is currently being improved by research being carried out as part of the WAVE project (Weigh-in-motion of Axles and Vehicles for Europe). This project **is** funded by the European Commission and will be implemented by a consortium of 15 partners from 11 European countries in 1996 and 1997. A number of alternative pavement and bridge WlM systems are being considered in WAVE and part of the Irish contribution is to apply the bridge system to culverts.

Main Roads, Western Australia, having initially developed a bridge WiM system, have in recent years moved almost exclusively to a system based on culverts such as illustrated in Figure 1. The performance and accuracy of both culvert systems are discussed in this paper.

1.1 Basis of Culvert Systems

Both the Australian and European systems are derived from the American system developed by Moses (1). As a result, they both have many common features. The basic principle consists of relating the bending strains in a culvert deck caused by the passage of a vehicle overhead to the axle weights of that vehicle. The relationship is established by recording the strains induced by a vehicle whose axles have been weighed statically. In addition to axle weights, vehicle speed, axle number and spacing, and the date and time of the event are recorded. The strains are measured using a number of electrical resistance gauges placed transversely across the culvert soffit, usually

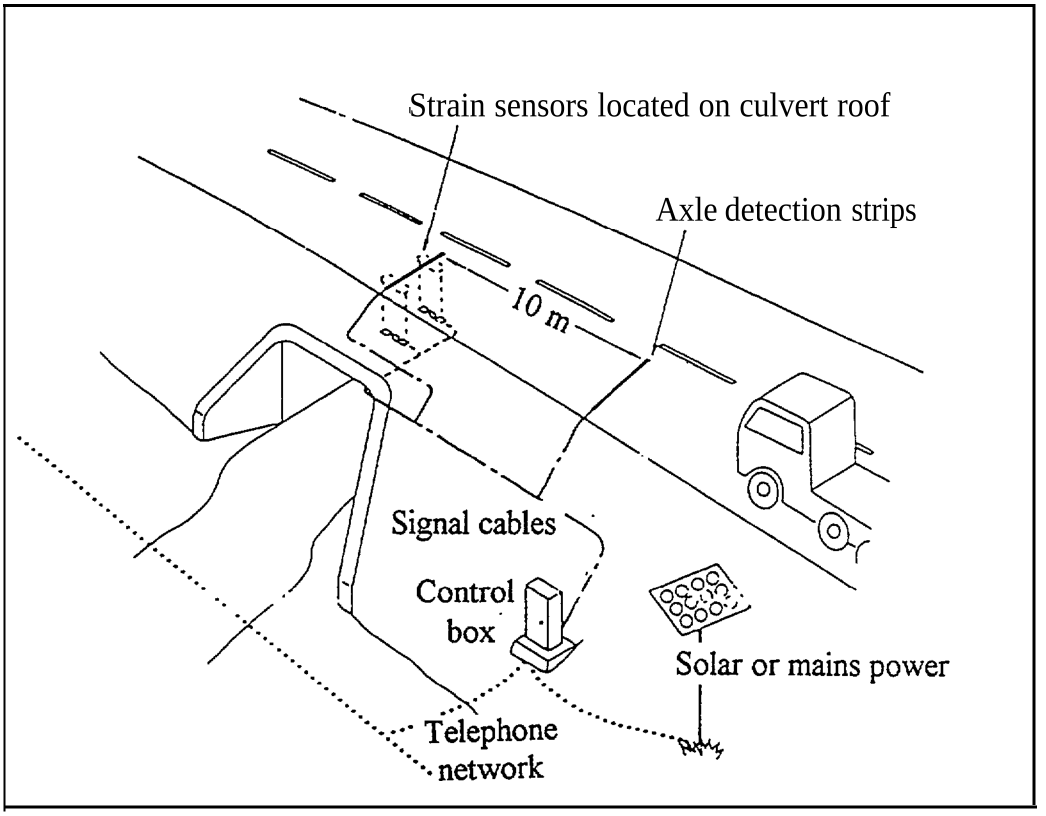

Figure 1 - Typical Australian culvert installation

at midspan. Mechanical strain amplifiers are used to enhance the strain signal. The strains at each gauge are added to obtain a characteristic response similar to a theoretical bending moment influence line. Figure 2 shows the characteristic moment response of a four metre span culvert to a four-axle truck. The truck axle weights, starting from the steer axle, are 90 kN, 190 kN, 140 kN and 140 kN and the corresponding spacings are 3.4 m, 6 m and 1.8 m. Typical peaks can be seen in the figure corresponding to individual axles of the vehicle.

1.2 Site Factors

The Australian experience over twelve years has identified a number of site specific factors which can have an effect on the overall accuracy of a culvert based system. As the system has nearly always used existing culverts, site quality has at times been a problem. As a consequence the following guidelines have been established for the selection of an 'ideal' culvert in order to minimise weighing errors:

- Single span reinforced concrete box culvert, precast, 'uncracked' and less than 2.7m in span;
- A smooth road surface - ideally the culvert would have been installed when the road was built;
- A straight and flat road;

- Culvert square to the road - a little skew is tolerable;
- Pavement cover - more than 200mm but less than 1500mm on top of the culvert; and
- Minimal pavement crossfall and minimal culvert gradient.

Figure 2 - Characteristic response of culvert to 4-axle truck

2. ACCURACY OF EUROPEAN SYSTEM

In addition to its application at a number of sites in Ireland, the European system has been tested on a bridge in Slovenia where it was compared with a commercially available American system. This short term comparison found both systems to give similar levels of accuracy.

The European system is triggered by pneumatic road hoses acting as axle detectors which initiate the recording of strains before the vehicle passes over the culvert. All data is recorded and stored on a portable computer for subsequent downloading and post-processing. The system does not calculate axle weights for vehicles in real time.

There are differences in the recorded characteristic responses from trucks with the same axle configurations and weights due to variations in transverse truck location, sensor inaccuracies, site factors and vehicle dynamics. The dynamic effects on the system are largely those which occur within the vehicle itself The culverts, being buried and of short span, do not generally display any significant dynamic response as in the case of a bridge, The level of the dynamic effect is related to the smoothness of the surface on the approach to the culvert. The resulting oscillations in the vehicle cause the axle weights to be recorded as heavy or light. In order to overcome this, it is necessary to obtain at least one fit11 cycle of the oscillation for each axle. This presents a difficulty because of the relatively short spans that are typical of culverts.

The characteristic response is a linear combination of influence ordinates factored by the axle weights (1). Thus one linear equation can be written for each strain record. For a truck of *n axles*, *n* records of strain are identified corresponding to *n* different points in time. In matrix form the *n* equations can be written as:

$$\{\varepsilon\} = [I]\ \{W\} \qquad (1)$$

where $\{\varepsilon\}$ is the vector of recorded strains, [I] is the matrix of appropriate influence ordinates and {W} is the vector of unknown axle weights. While electrical resistance strain gauges are very accurate, significant errors in the strain records can result from many effects such as, for example, truck 'bounce'. To simulate gauge errors numerically, the components of this $\{\varepsilon\}$ vector have been multiplied by a random number reflecting a possible range of error of +/- 2.5%. The modified vector is termed $\{\varepsilon\}^*$. The new inferred axle weights {W}* are given by:

$$\{W\}^* = [I]^{-1}\ \{\varepsilon\}^* \qquad (2)$$

Using the culvert and truck described in Section 1.1 above, errors in inferred axle weights have been determined for a number of different random combinations of gauge errors. The results are illustrated in Figure 3. Only the extremes of the four strain errors and the four axle weight errors are shown in this figure. Hence only four points are illustrated for each simulation. Clearly the inferred axle weights are sensitive to the accuracy of the strain data. In general, inferred axle weight errors are about double the error in the input data.

3. ACCURACY OF AUSTRALIAN SYSTEM

The Australian 'Culway' system was originally conceived and tested by Main Roads Western Australia in 1984 (2). It has been used widely throughout Australia since then, with over 100 systems currently in operation. Arguably its greatest features are its robustness, low cost and acceptable accuracy. Unliie most WIM systems, the sensors are not subject to the battering of tyres and the vagaries of the weather, with the result that Culway needs little or no site maintenance.

Much work has been undertaken in the area of accuracy. Culway has been found to typically estimate static gross vehicle weight within +/- l0%, and the individual axle weight within +/- 15% at 95% confidence limits (4). The accuracy at some sites has been found to be better than this, and at others to be worse.

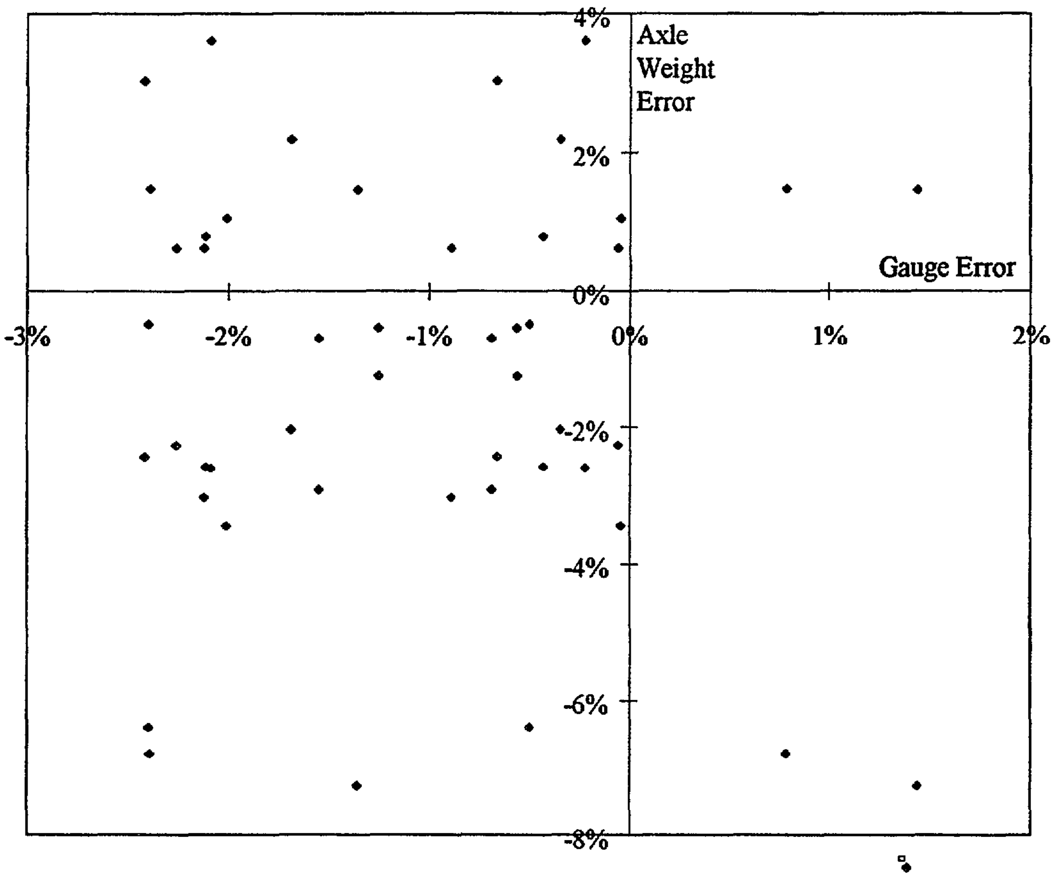

Figure 3 - Influence of gauge errors on inferred axle weights

3.1 Culway's Comparative Accuracy

Samuels (4) undertook a series of tests to assess the accuracy of Culway and several other highway speed WIM systems, the results of which are given in Table 1. He used vehicles of known axle weight in all cases. In essence he found that most of the systems were of similar accuracy, with the exception of the surface mounted capacitive pad. This was not unexpected, as the capacitive pad by virtue of its not being flush with the road surface, introduced additional dynamic effects. Culway was found to be as accurate as the more expensive and high maintenance plate-in-road systems. The bridge systems, Fastweigh and Axway, were also similar.

3.2 Long Term Accuracy

Culway has now been used in Australia for over 10 years, and its long term accuracy has been investigated to some extent. The fact that the pavement materials over the culvert are subject to seasonal moisture, temperature and stiffness variation has always raised some concerns. Scott (5) found long term variation to be generally small, except in the case of a new culvert, where strains reduced by 27% in the period from two to six months after first exposure to traffic.

Table 1 - Accuracy of Various WIM Systems

WIM System	Gross Vehicle Weight		Tandem Axle Group Weight[1]	
	Mean Error %	95% C.L.	Mean Error %	95% C.L.
HSEMU (Australian plate in ground on load cells)	2.3	+/- 8.6	1.1	+/- 12
PAT (German strain gauged plate in ground)	1.6	+/- 5.3	3.3	+/- 5.7
CULWAY	-2.7	+/- 6.8	-0.9	+/- 9.9
AXWAY (Australian instrumented bridge)	-1.6	+/- 9.8	-	-
FASTWEIGH (American instrumented bridge)	-0.6	+/- 5.6	-0.2	+/- 14
Golden River (Surface mounted capacitive weigh pad)	-3.0	+/- 18.0	-	-

Figure 4 shows the variation over a year in the average measured mass of the steer axle of six articulated vehicles at a site in Western Australia (6). It is felt that the actual static weights of these steer axles do not vary much, and as such are an independent measure of system accuracy. (A similar method is used for quality assurance of WIM data in the United States and Canada (7)). The site from which this data was collected should have been quite stable. Pavement moisture content should only vary slightly (highest around September), there is no frost, and there is no asphalt.

3.3 Errors Due to Lateral Positions of Trucks

Variations due to other sources of error have also been investigated. Thillainath and Hood (8) developed a method of further reducing Culway error which took into account the measured variations in the response of the individual strain sensors. Usually Culway simply adds the strain response of each sensor. This method aimed to minimise weighing variations due to variations in the lateral position of vehicles. At sites where lateral variation was an issue, the method proved to be valuable.

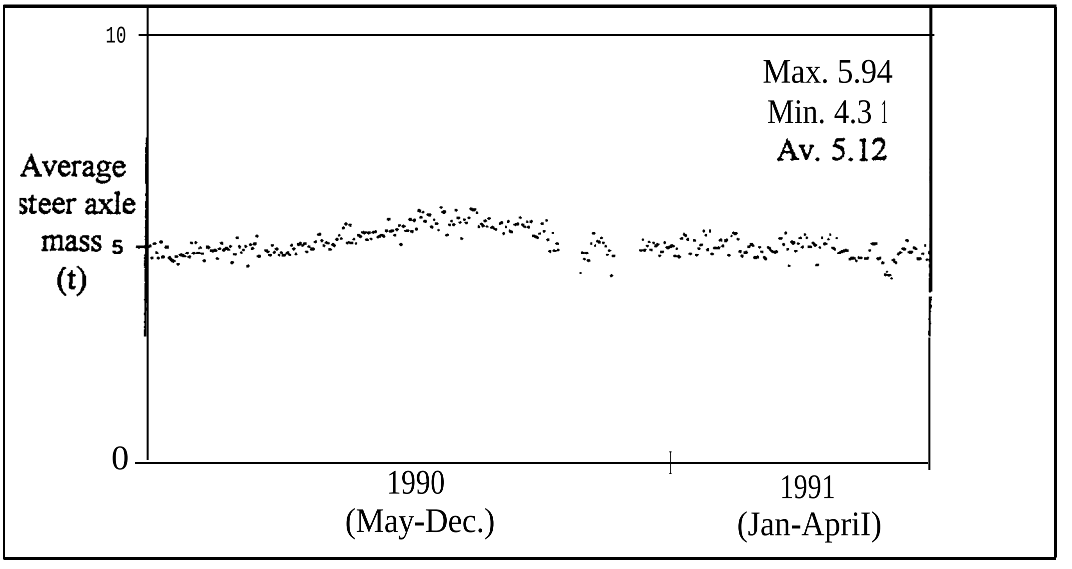

Figure 4 - Variation in average steer axle mass

3.4 **Vehicle Speed Effects**

Culway sites are calibrated using trucks traveling at the sort of speeds that could be reasonably expected. Tests have indicated that speed has little effect on the weights measured. Peters (2) has reported the results given in Table 2 for a two-axle truck.

Table 2 - Culway - Vehicle Speed Effects

Speed (km/h)	60	70	so	90	**100**
Steer Weight(t)	2.9	3.2	2.9	3.0	3.1
Drive Weight (t)	9.0	9.1	9.1	8.9	9.3
Cross Weight (t)	11.9	12.3	12.0	11.9	12.3

3.5 Underweighing Steer Axles

Culway, without corrections, has continually under-weighed steer axles. Many theories have been put forward as to why, but the issue has never been resolved. The theories include:

- Smaller contact area of type- seems counter intuitive;
- Strain non-linearity of concrete - evidence seems to cast doubt on this; and
- Dynamic weight of steer axles is less than the static weight, due to aerodynamic and torque effects.

Culway manages the issue with a site-specific correction factor for steer axle weights.

3.6 Vehicle and Culvert Dynamics

One of the major advantages of Culway is the fact the culverts do not seem to vibrate when a vehicle passes over them. They are totally restrained and damped by the surrounding embankment and pavement. This means that the strain measured on the roof of the culvert is simply that induced by the mass of the vehicle's wheels, and to a minor extent the dynamic load of the vehicle. The pavement also filters/damps out high frequency vibrations. The strain signal is clean and does not require any filtering to remove any extraneous influences. Despite this, the pavement material is adequately stiff to transmit the wheel loads to the concrete culvert. Figure 5 is a typical unfiltered strain response to the passage of a heavy truck.

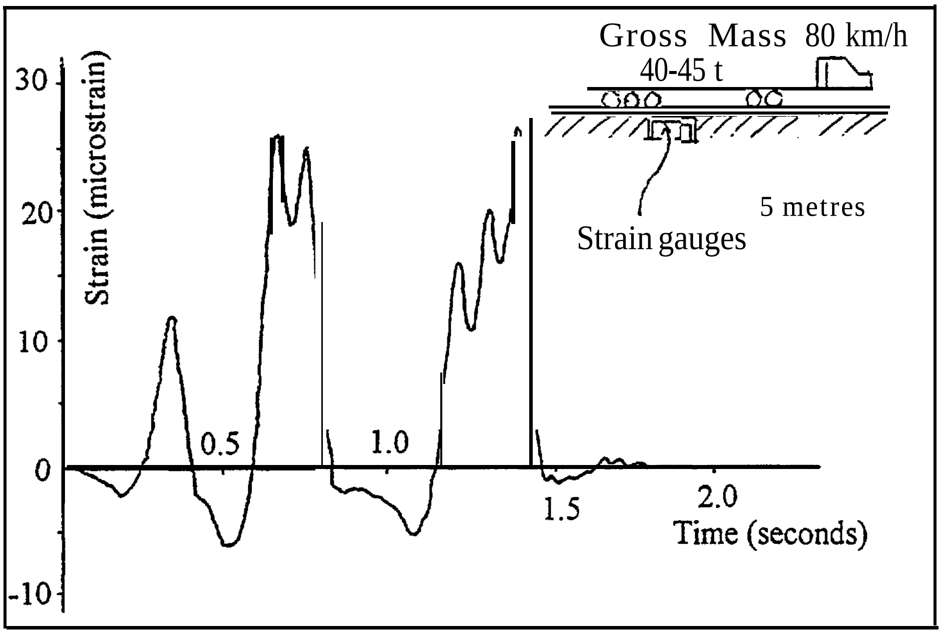

Figure 5 - Typical culvert strain response

The fact that Culway installations do not introduce any discontinuities into the riding surface (no expansion joints, no junctions between stiff and flexible materials, no steps) means that there is no excitation of the vehicle dynamics as a result of the weighing installation. The vehicle **is** truly unaware of having been weighed. This means that the only dynamic effects are those inherent to the vehicle and the normal road surface profile, When culverts were first instrumented in the formative days of Culway, the strain responses were soon seen to be very clean, making the development of an algorithm to convert the strains into mass very much simpler. The algorithm developed at that time, and still used, is described in detail by Peters (2).

4, CONCLUSIONS

This paper describes the culvert WIM systems in use and under development respectively in Australia and Europe. The theoretical error which results from various factors is illustrated for the European system. The Australian system has proven to be a robust and accurate WIM system that has now stood the test of time. It, like all WIM systems, is not without its problems, but in general it weighs as accurately as many of the best, and at a lower cost.

REFERENCES

1. Moses, F., 'Weigh-in-Motion System Using Instrumented Bridges', *Transportation Engineering Journal*, ASCE, 105, TE3,1979, pp 233-249.
2. Peters, R.J., 'CULWAY - An Unmanned and Undetectable Highway Speed Vehicle Weighing System', *Proc. 13th ARRB Conference*, 13(6), 1986, pp70-83.
3. Dempsey, A.T., O'Brien, E.J. and O'Connor, J.M., 'A bridge Weigh-in-Motion system for the determination of gross vehicle weights' in *Post-Proceedings of First European Conference on Weigh-in-Motion of Road Vehicles*, eds. B. Jacob et al., ETH, Zurich, 1995, pp239-249.
4. Samuels, S.E., 'Development and Evaluation of Highway Speed Weigh-in-Motion Systems in Australia', *ARRB SR40*, Australian Road Research Board, 1988.
5. Scott, G., 'Weigh-in-Motion Technology: Status of Culway in Australia', ARRB seminar, 1987, pp25-45.
6. Hood, R.G. and Peters, R.J., 'Culway in Western Australia', *Proc. 16th AARB Conference*, 16(7), 1992, pp200-215.
7. Hallenbeck, M., 'Quality assurance and automated error detection for WIM and AVC equipment in the long term pavement performance (LTPP) project' *in Pre-Proceedings of the First European Conference on Weigh-in-Motion of Road Vehicles*, ETH, Zurich, March 1995, pp279-287.
8. Thillainath, S.J. and Hood, R.G., 'An Improved Method of Culway Calibration', *Proc. 15th ARRB Conference*, 15(6), 1990, pp80-97.

HITEC EVALUATION

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HITEC EVALUATION AND CLEARINGHOUSE EFFORTS TO FACILITATE UNDERSTANDING AND ACCEPTANCE OF WEIGH-IN-MOTION TECHNOLOGY BY THE STATE DEPARTMENTS OF TRANSPORTATION

DAVID REYNAUD

HITEC

HITEC, **the Highway Innovative** Technology Evaluation Center, is a service center of the Civil Engineering Research Foundation (CERF), the research affiliate of ASCE. It has been established through a cooperative agreement with the Federal Highway Administration (FHWA) to facilitate the conduct of national evaluations of new products and act as a clearinghouse in order to expedite the acceptance **of** innovative technologies throughout the highway and bridge market.

Presently, we are collaborating with the SHRP Long Term Pavement Performance Program to plan and conduct an evaluation program for proprietary weigh-in-motion sensor systems. Under this program, HITEC. will accept applications from suppliers of these systems and form a Technical Evaluation Panel comprised of professionals familiar with weigh-in-motion sensor technology. Panelists may come from the FHWA, state DOT's, academia or consulting engineering firms.

In assessing the problems in the current Weigh-in-Motion environment and the possible role for a HITEC Evaluation Panel to assist in some way to sort them out, the following items seemed to stand out:

The procurement process needs to reflect the true equipment and support requirements for reliable, accurate data production. The current scenario, in many cases, involves a highway general contractor purchasing and installing hardware that was chosen on the basis of **cost alone and** shopped to the point of eliminating any service budget that may have been in the original price. Our panel would work closely with AASHTO to develop a model specification for state DOT's to assure **that** they are purchasing all the elements necessary to generate relevant data over the desired time span.

A nationally recognized program to test and classify WIM systems based on performance longevity and accuracy is needed to help state DOT's choose the proper tool for their intended time frame and purpose.

Product specific guidelines for the installation, calibration and maintenance of WIM systems both in written and video formats are necessary to provide a reference for the user community both from the standpoint of understanding the site planning and budgetary requirements and in order to train their inspection forces.

We plan to have a panel established by May and will report on the progress toward the solution of the above problems and any others that are identified by the panelists or vendors involved.

WAVE-A EUROPEAN PROJECT ON WEIGH-IN-MOTION

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WAVE - A European Research Project on Weigh-in-Motion

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Abstract: WAVE (Weigh-in-motion of Axles and Vehicles for Europe) is a research project, part-funded by the European Commission, with the objective of improving the accuracy and performance of Weigh-in-Motion (WIM) technology. It has a budget of the order of $ 2 million and will run from mid 1996 to mid 1998. It has close links and a substantial overlap of membership with COST323, a pan-European group with representatives from about 20 countries which coordinates nationally funded activities relating to WIM. The principal objectives of WAVE are: (i) to improve the accuracy of WIM systems, (ii) to develop a prototype pan-European WIM database, (iii) to develop calibration and testing procedures for WIM system performance and accuracy, particularly for cold climates and (iv) to develop a prototype fibre optic WIM sensor.

1. INTRODUCTION

WAVE (Weigh-in-motion of Axles and Vehicles for Europe) is a pan European research project with the objective of improving the accuracy and performance of Weigh-in-Motion (WIM) systems. The research is being carried out by six full partner organisations, five associate partners and a number of other sub-contractors. The consortium, consisting primarily of national road research authorities, spans eleven countries from the arctic to the Mediterranean. It is lead by the French Road and Bridge Research Authority, Laboratoire Central des Ponts et Chausees (LCPC), and is part-funded by the European Commission. There are four principal objectives to the research:

1. **Accuracy:** Improvement of the accuracy of WIM systems
2. **Database:** Development of improved pan-European procedures for the checking, processing and storage of WIM data
3. **Cold climates/Calibration:** Verification of performance of WIM systems, particularly in sub-arctic and alpine climates
4. **Fibre optic WIM:** Development of fibre optic WIM technology

These objectives will be realised over a two-year period in 1996-98 through theoretical development, experimentation and full-scale field testing. The dissemination of results will be improved though close links with the European COST323 committee on Weigh-in-Motion of Road Vehicles (1). This committee has representatives from twenty countries from the European Union and Central/Eastern Europe.

2. HISTORY OF WAVE PROPOSAL

Considerable developments in WIM research have been taking place in Europe for many years, particularly in France and in the United Kingdom. In recent years the national road research authorities of the European Free Trade Association (FFTA) have acknowledged the need for a concerted approach on road infrastructure and have formed 'FEHRI,', the **Forum** of European Highway Research Laboratories. This forum has agreed on a list of priority research areas and has lobbied the European Commission Transport Directorate to sponsor the research. Following the inclusion of WIM on the priority list, the European Commission agreed in 1993 to fund COST323 (l), a European action with the objective of promoting the research and development of WIM technology. Subsequently a call was issued by the Commission in the 4th Framework Programme/Specific Transport Programme (1996-98), for a full research programme on WIM. The WAVE consortium was the successful applicant.

2.1 COST323

The European COST programme does not fund significant research in itself but funds and facilitates cooperation between countries carrying out research at national level. The first full management committee meeting of COST323 was held in 1993 and the committee will continue in existence until after the conclusion of the WAVE project in 1998. The activities of the group, presented at the NATDAC '94 conference (l), include:

1. Collection and analysis of WIM needs in Europe.
2. Testing of proprietary and prototype WIM systems. An extensive test of eight WIM systems has recently been completed in Zurich (2). Further tests will be carried out in the future in lapland Sweden and on a French motorway, the A3 1 in eastern France between Metz and Nancy, which is one of the main north-south road links in Western Europe.
3. Preliminary work on the development of a European standard on WIM. This includes the definition of relevant terms and the translation of these into a range of European languages. A draft pre-standard will also be developed which may in the future result in an official European standard.
4. Agreement of mechanisms and protocols for a pan-European database of WIM sites and data.
5. Organisation of international conferences. The first European WIM conference was held in Switzerland in 1995 (3). A second is planned for Southern Europe in 1998.

2.2 Relationship between WAVE and COST323

In 1994, the European Commission issued a call for applications to the $10 billion Fourth Framework Research Programme. The specific Transport Programme was allocated $300 million, of which 11% was designated for road transport. One third of this amount, about $9 million, was allocated to road infrastructure. A substantial thematic part of this sub-programme included a request for research on WIM. The WAVE consortium applied to carry out this research and was successful. This consortium has a substantial overlap in its membership with that of COST323. While COST323 does not fund research in itself, it provides a very effective means of disseminating the results of research carried out at either national or European level. Thus, for example, COST323 will co-sponsor a cold climate test being carried out through WAVE in Sweden. Also, COST323 will organise a conference in 1998 to facilitate the publication of the results of WAVE. In addition it will provide a broader forum in which to secure agreement on standardisation of calibration procedures and database protocols which will be developed through WAVE.

3. PROPOSED RESEARCH

The WAVE project is divided **into** four work packages, which can briefly be described as (i) accuracy, (ii) database, (iii) cold climates/calibration and (iv) fibre optic WIM. These are described in turn in the following sections.

3.1 Accuracy

The purpose of the first work package is to develop WIM systems which can produce accurate and reliable data for static axle and gross vehicle weight. The specific target accuracy for axle weights **is** that 95 to 99% of results should have an error within **±10%** or a root mean square error of about 4%. For gross vehicle weights, the target is that 95 to 99% of results should have an error within **±5%,** or a root mean square error of about 2%.

Two techniques are being investigated which can be used either as alternatives or in combination. These are multiple sensor systems and bridge systems. Both techniques have already been studied and tested on a small scale in Europe and North America, but require significant further development in order to achieve the target levels of accuracy.

Multiple-sensor WIM: There is an upper limit on the accuracy of individual WIM strip sensors due to the effect of truck bounce. Research carried out under the OECD/DIVINE project (4) has shown that dynamic axle forces exceed the corresponding static weights by between 15% and 40% depending on the pavement eveness and the vehicle suspension. Regardless of the accuracy of strip sensors, they can only provide axle weight for one point in time. This problem can be overcome by using a number of low-cost strip sensors (capacitive or piezo-electric). The use of large base sensors (bending plates, weighing scales) only partially solves the problem by improving the intrinsic accuracy of wheel impact force measurement, but cannot eliminate the dynamic effect because it only measures the wheel impact during a short portion of the eigenperiod of vibration.

Spatial repeatability, i.e., a correlation between relative dynamic force and pavement profile, has been established at sites in the United Kingdom (5) and France (6). Knowledge of this phenomenon can be exploited in the design of arrays of WIM sensors, both for optimal sensor layout and for the calculation of a best estimate of the static axle weight from the measured dynamic weights.

The simple sensor averaging strategy devised in previous Anglo-French (7) research makes only limited use of the known models of vehicle dynamics, and of the known range of parameters for these models. The purpose of the new research on multiple sensor WIM will be to exploit knowledge of vehicle dynamics to the full in order to:

- improve the accuracy of weight estimates;
- minimise the number of sensors required in multiple-sensor arrays to achieve a specified accuracy;
- determine the optimal (uniform or non-uniform) sensor spacing;
- estimate from the sensor data other characteristics, such as resonance frequencies and vehicle suspension parameters.

Bridge WIM: The concept of using bridges as scales to weigh trucks in motion was developed by Moses and others in the 1970's (8). The method has considerable potential for accuracy as it allows measurement of impact forces over more than one eigenperiod. As bridges are large, a great number of sensor readings can be recorded during the time it takes for a truck to cross. Full exploitation of this information can be used to gain information on the dynamic behaviour of the truck whose axle weights are being sought. This in turn can be used to obtain a more accurate estimate of the static axle weights. Alternative strategies being investigated are the use of bridge sensors alone and the use of a combination of bridge and traditional pavement WIM sensors. A considerable research effort will also be expended in the development of more sophisticated dynamic models than those currently used.

Bridge systems may have some advantages over conventional WIM systems in terms of durability, particularly in sub-arctic and alpine climates. However, a major disadvantage is the problem of finding a suitable bridge at the desired location. In recognition of this, part of the work package concerns the testing of bridge WIM on a wide range of bridge types including concrete slabs, box culverts, arches and cable-stayed orthotropic steel decks. In addition, systems will be tested in a range of European climates. Bridges in Ireland, France, Slovenia, Germany and Sweden will be considered.

3.2 Database

Development of improved pan-European procedures for the checking, processing and storing of WIM data is an important objective of the WAVE project. In most European countries WIM data is being collected for different purposes. An increasing demand on WIM data at European level makes the exchangeability of WIM data between different countries an important issue. The principal task of the second work package of WAVE is the preparation of a prototype European WIM database. This is expected to be a source of information for all potential WIM-data users such as traffic engineers, road research laboratories and road or bridge designers.

The development of systems for ensuring the quality of data will be an important part of this work package. For this, results from the COST323 action may be used, particularly the preparatory work for the European Standardisation committee, CEN/TC226 containing European specifications for WIM. Quality parameters will be defined and procedures will be described for WIM system users to check, ensure and classify the quality of data. Experience gained from the American LTPP project (9) will be of great interest for this task.

It is envisaged that all countries providing WIM data for a European database will be capable of transferring their data in a standardised prescribed format. This means that, for example, a location code based on the European road numbering system will be provided. The introduction of such a format description will also stimulate WIM data exchange between countries in order to encourage integrated long term maintenance strategies for international transport routes.

3.3 Cold Climates/Calibration

If WIM data is to be used at a pan-European level and particularly if it is to be used for future pan-European legistation and enforcement, it is essential that there be consistency in the accuracy of the results for all climates. It is also important that all regions of the continent have fair access to the technology. To ensure consistency of accuracy there is a need for standard methods of calibration and testing of WIM systems. To ensure that all regions have fair access, problems of both accuracy and durability in cold climates must be overcome. The third work package of WAVE thus contains two closely interrelated activities, namely, durability in cold climates and calibration/test procedures.

Durability in cold climates: A major test of existing and prototype WIM systems will be carried out in the harsh climate of northern Sweden. European WIM-vendors will be invited to install their systems and tests will be carried out both under Summer and Winter conditions. The accuracy of the systems and-their durability under conditions of snow and studded tyres will be assessed.

Calibration/Test Procedures: The purpose of the second part of this work package is to develop and specify calibration methods. In particular, such methods must cater for the sensitivity of WIM systems to temperature for the wide range that exists across Europe. Measurements will be carried out using preweighed and instrumented trucks at test sites near Lulea, in Northern Sweden close to the Finnish border, on the RN1 0 and A3 1 test sites in France and on the Abington site in the United Kingdom. Ideal properties of instrumented trucks will be specified with a view to the possible use of standardised instrumented vehicles or trailers across Europe.

3.4 Fibre Optic WIM

The simplest way to use optical fibres as sensors emerged during the 1970's when the intensity or amplitude of light passing through fibres was found to be proportional to applied strain. Based on this principle, some portable WIM systems were developed at Oak Ridge National Laboratory (Tenessee) which have recently been made available commercially in Canada.

An alternative approach to the use of optical fibres as sensors is to exploit the concept of mode combining for multimode fibres or polarization effects for single-mode fibres. The first of these has been investigated by the University of Liverpool in partnership with the United Kingdom Transport and Research Laboratory. The second, which exploits what was considered to be a polarizing effect due to an induced bi-refringence in single-mode fibres under loading, was shown to be feasible by Alcatel in partnership with LCPC in 1986. There are a number of advantages in the latter approach:

- high sensitivity with a range extending from pedestrian to heavy trucks with high accuracy (3%) and reliability,
- completeness of information,
- real-time response,
- response in digital form,
- no power source required along the roadway,
- immunity to lightning and electromagnetic interference,
- ease of installation.

Before 1980, due to the lack of technology, it was very difficult to exploit the optical phase from a given state of polarization in a fibre. The better understanding of this complex phenomenon available today has resulted in the availability of numerous components such as polarisation maintaining fibres, polarisers/depolarisers, polariser controllers, etc..

A single-mode fibre could be a WIM sensor by itself but, depending on the state of polarization of the light propagating within the core, the response to many parameters would be detected. In order to isolate the feature of interest from a perturbation generated by a tyre, a sensing structure must be developed and the corresponding optical link for sensor interrogation. This so-called sensing structure will be developed; specifically, a method will be developed for the encapsulation of the fibre in a material compatible in terms of Young's modulus. Also, it is felt by the consortium that the best way to increase sensitivity is to interrogate the sensor by reflection instead of direct transmission. That means that a mirror must be designed for location at the end of the sensing structure.

3. WAVE ADMINISTRATION

The WAVE partnership consists of a coordinating partner, five full partners and five associate partners as listed (with abbreviations) in Table 1. The associate partners report to the full partners as illustrated in Figure 1. This structure reflects, to some extent, the make-up of the teams which will carry out the four work packages. LCPC and CUED share responsibility for the Multiple sensor WIM part of the Accuracy work package. AKN and ETH also participate in this and two subcontractors, Golden River and the Transport Research Laboratory (United Kingdom) report to CUED. The Irish university, TCD, is responsible for the Bridge WIM part of the Accuracy work package. They are assisted by associate partners, TUM and ZAG and the French laboratory, LCPC, also participates.

Table 1 - Partners and Associate Partners

No.	Grade of Membership (full partner to which reporting)	Name of Organisation	Abbrev-iation	Country
1	Coordinating partner	Laboratoire Central des Ponts et Chaussees	LCPC	France
2	Full partner	Cambridge University Engineering Department	CUED	United Kingdom
3	Full partner	Trinity College Dublin	TCD	Ireland
4	Full partner	Road Hydraulic Engineering Division	DWW	Holland
5	Full partner	Alcatel Kable Norge	AKN	Norway
6	Full partner	Swedish National Road Administration	SNRA	Sweden
7	Assoc. partner (4)	Belgium Road Research Centre	BRRC	Belgium
8	Assoc. partner (3)	Technische Universitat Munchen	TUM	Germany
9	Assoc. partner (6)	Technical Research Centre of Finland	VTT	Finland
10	Assoc. partner (6)	Swiss Federal Institute of Technology	ETH	Switzer-land
11	Assoc. partner (3)	National Building & Civil Engineering Institute, Slovenia	ZAG	Slovenia

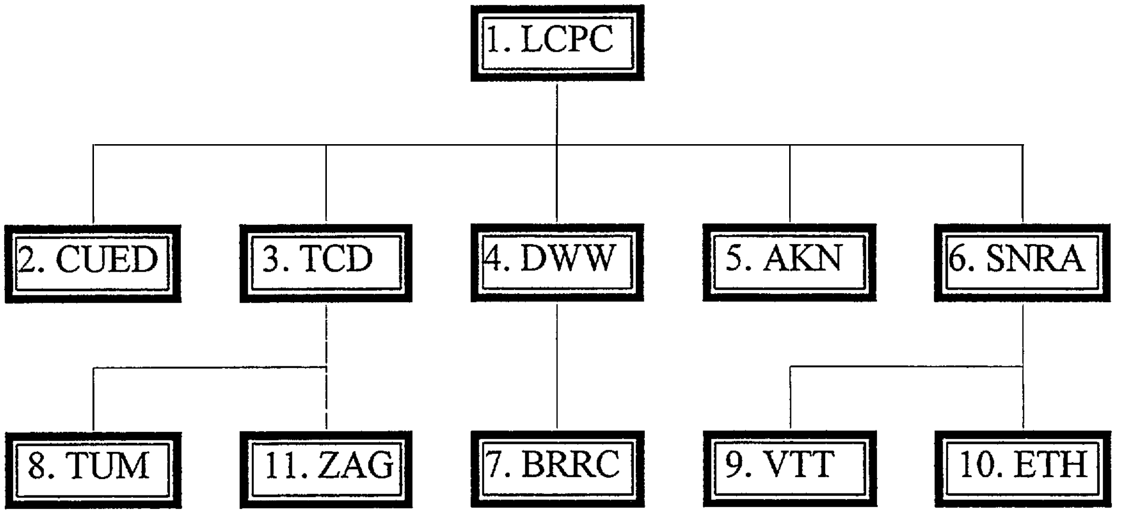

Figure 1 - Organisation chart for WAVE consortium

The Dutch authority, DWW is responsible for the second work package, Database, and they are assisted by the Belgian associate partner, BRRC. LCPC, SNRA and ZAG also participate in this work package which is of interest to many members of the consortium.

The Swedish road administration, SNRA, is responsible for the Cold climates part of the third work package. The Finnish and Swiss associate partners, VTT and ETH report to SNRA while AKN and TCD also participate. The Calibration part of this work package is coordinated by LCPC and VTT, and many members of the consortium participate - CUED, TCD, SNRA, BRRC and ETH.

The fourth work package, Fibre optic WIM, is shared between the LCPC and the Norwegian company, AKN. The partners are being assisted by one subcontractor, Applications Mathematiques et Logiciels.

Budget; The WAVE project is supported by the European Commission on a 'shared cost' basis. This means that non-university organisations must provide 50% of their total costs. Universities are 100% funded but on a marginal cost basis, i.e., no funding is provided for the time of permanent staff or for the use of existing equipment. Partners from Eastern Europe such as Slovenia are likely to be funded as soon as a special agreement is signed with the EU. Partners from countries outside the European Union such as Switzerland may partake in European research projects but are not funded by the commission. The total WAVE budget is of the order of $2 million of which the European commission will provide about 45%.

5. CONCLUSIONS

The WAVE research project on Weigh-in-Motion is described in this paper and the developments leading to the call by the European Commission for research on WIM are presented. This process started with the Forum of European Highway Research Laboratories, lead to COST323 and finally to WAVE. A detailed technical description is given of the four work packages of proposed research. Finally the complete partnership is listed and the structure of responsibilities within the elaborate consortium is described and illustrated.

References

1. Jacob, B., European Research Activity COST323 - Weigh-In-Motion of Road Vehicles, proceedings of NATDAC'94 conference, Rocky Hill, Connecticut, 18-22 Sept. 1994.
2. Doupal, E. and Caprez, M., 'European Test of WIM Systems in Switzerland',in *Post-proceedings of the First European Conference on Weigh-in-Motion of Road Vehicles,* Eds. B. Jacob et al., ETH, Zurich, March 1995, ppl89-207.
3. COST323, *Pre-* and *Post-proceedings of the First European Conference on Weigh-in-Motion of Road Vehicles*, Eds. B. Jacob et al., ETH, Zurich, 8-10 March, 1995.
4. Huhtala, M. and Jacob, B., 'OECD DIVINE Project - Spatial Repeatability of Axle Impact Forces', in *Post-proceedings of the First European Conference on Weigh-in-Motion of Road Vehicles,* Eds. B. Jacob et al., ETH, Zurich, March 1995, pp121-132.
5. Barbour, I.A. and Newton, W.H., 'Multiple-Sensor Weigh-in-Motion', in *Post-proceedings of the First European Conference on Weigh-in-Motion of Road Vehicles,* Eds. B. Jacob et al., ETH, Zurich, March 1995, pp133-142.
6. O'Connor, T., O'Brien, E.J. and Jacob, B., 'An Experimental Investigation of Spatial Repeatability', to be presented at *Vehicle-Infrastructure Interaction IV, San* Diego, June 1996 and to be submitted to the Special Conference Issue of *Heavy Vehicle Systems.*
7. Cole, D.J., Cebon, D., Collop, A.C. and Potter, T.E.C., 'Multiple-Sensor Arrays for Weigh-in-Motion and Suspension Assessment', in *Post-proceedings of the First European Conference on Weigh-in-Motion of Road Vehicles,* Eds. B. Jacob et al., ETH, Zurich, March 1995, pp143-15 1.
8. Moses, F., 'Weigh-in-Motion System Using Instrumented Bridges', Transportation Engineering Journal of ASCE, *Proceedings of the American Society of Civil Engineers,* Vol. 105, No. TE3, May 1979, pp233-249.
9. Hallenbeck, M., 'Quality Assurance and Automated Error Detection for WIM and AVC Equipment in the Long Term Pavement Performance (LTPP) Project', in *Post-proceedings of the First European Conference on Weigh-in-Motion of Road Vehicles,* Eds. B. Jacob et al., ETH, Zurich, March 1995, pp209-217.

STATE TRAFFIC MONITORING EQUIPMENT SURVEY

Office of Information Management

Presented at
National Traffic Data Acquisition Conference
Albuquerque, New Mexico

May 5-9, 1996

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
** State: AK						
3	G K INSTRUMENTS		TUBES	101	100	04/15/96
2	G K INSTRUMENTS	GK 6000	LOOPS	5	5	04/15/96
2	GOLDEN RIVER	331	LOOP/TUBE/SWITC	6	0	04/15/96
2	GOLDEN RIVER	331 & 341	TUBES & LOOPS	33	800	04/15/96
2	GOLDEN RIVER	331 & 341	LOOPS	31	31	04/15/96
2	GOLDEN RIVER	334	LOOP/TUBE/SWITC	8	0	04/15/96
1	GOLDEN RIVER	340	LOOP/TUBE/SWITC	3	3	04/15/96
2	GOLDEN RIVER	340	LOOP/TUBE/SWITC	3	3	04/15/96
1	GOLDEN RIVER	341	LOOPS	14	17	04/15/96
3	GOLDEN RIVER	ARCHER	TUBES	5	100	04/15/96
1	GOLDEN RIVER	ARCHER 400	LOOPS	3	0	04/15/96
3	GOLDEN RIVER	ARCHER 400	LOOPS	3	0	04/15/96
4	GOLDEN RIVER	WEIGHMAN	MAT/LOOP	1	0	04/15/96
1	I R D	TCC 500	LOOPS	2	1	04/15/96
4	P A T		PIEZO	1	1	11/19/92
** State: AL						
4	AVIAR - TRUVELO	TDL 500	CAP. MAT	4	25	09/08/94
1	DIAMOND	TT 2001	LOOPS	1	1	09/08/94
3	DIAMOND	TT 2001	TUBES	78	0	09/08/94
3	DIAMOND	UNICORN	TUBES	40	0	09/08/94
2	GOLDEN RIVER	MARKSMAN	LOOPS	74	74	09/08/94
4	I R D	1060P	LOOPS/PIEZO	16	16	09/08/94
1	I R D	1060P	Loops/Piezo	16	16	09/08/94
2	I R D	1060P	LOOPS/PIEZO	16	16	09/08/94
3	I R D	1060P	LOOPS/PIEZO	16	16	09/08/94
1	P A T	DAW 100	Loops	12	12	09/08/94
2	P A T	DAW 100	LOOPS	12	12	09/08/94
3	P A T	DAW 100	LOOPS	12	12	09/08/94
4	P A T	DAW 100	BENDING PLATE	12	12	09/08/94
3	PEEK	TRAFICOMP E-Z	TUBES	60	0	09/08/94
2	STREETER AMET	241	LOOP	7	4	09/08/94
1	STREETER RICHARDSON	141	LOOPS OR TUBES	7	32	09/08/94
1	STREETER RICHARDSON	241	Loops	7	4	09/08/94
** State: AR						
1	DIAMOND	PHOENIX	TUBES & PIEZO	12	6	03/23/96
2	DIAMOND	PHOENIX	TUBES & PIEZO	12	6	03/23/96
3	DIAMOND	PHOENIX	TUBES & PIEZO	12	6	03/23/96
1	DIAMOND	TT 2001	TUBES	5	0	03/23/96
3	DIAMOND	TT 2001	TUBES	5	0	03/23/96

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
3	G K INSTRUMENTS	GK 5000	TUBES	25	0	03/23/96
1	G K INSTRUMENTS	GK 5000	TUBES	25	0	03/23/96
2	G K INSTRUMENTS	GK 6000	PIEZO	21	18	03/23/96
3	G K INSTRUMENTS	GK 6000	PIEZO	21	18	03/23/96
4	G K INSTRUMENTS	GK 6000	PIEZO	21	18	03/23/96
1	G K INSTRUMENTS	GK 6000	PIEZO	21	18	03/23/96
3	INTERNATIONAL TRAFFIC	TRAF. RECORDER	TUBES	50	0	03/23/96
4	PEEK TRAFFIC	ADR	LOOPS	18	16	03/23/96
1	STREETER AMET	241	TUBES	41	0	03/23/96
3	STREETER AMET	241	TUBES	41	0	03/23/96
1	STREETER AMET	241	PIEZO	5	5	03/23/96
3	STREETER AMET	241	PIEZO	5	5	03/23/96
2	STREETER AMET	241L	PIEZO	5	5	03/23/96
** State: AZ						
2	GOLDEN RIVER	0331	6'X6'IND.LOOPS	122	0	07/28/87
1	GOLDEN RIVER	0340	LOOPS	8	0	10/26/94
4	GOLDEN RIVER	0348	LOOPS/MAT	2	0	10/26/94
2	GOLDEN RIVER	331	LOOPS	122	39	10/26/94
4	I R D		BENDING PLATE	1	1	10/26/94
3	I R D	TCC-530	PIEZO	80	0	10/26/94
1	I R D	TCC-530	LOOPS	80	30	10/26/94
4	P A T		PIEZO	1	1	10/26/94
** State: CA						
2	C M I	MICRO-COUNTS	LOOPS/TUBES	80	0	09/08/94
3	DIAMOND	PHOENIX	LOOP/TUBE/PIEZO	19	19	09/08/94
1	DIAMOND	TT 2001	LOOPS	1	1	09/08/94
2	DIAMOND	TT 2001	LOOPS	5	5	09/08/94
4	I R D	1060	BENDING PLATES	39	14	03/19/96
4	I R D	1060	PIEZO	8	2	03/19/96
4	I R D	1060	BENDING PLATES	12	6	03/19/96
4	I R D	1060	PIEZO	18	6	03/19/96
2	MODEL 170 CONTROLLER	170	LOOP	50	50	09/08/94
4	P A T	DAW 100	BENDING PLATES	10	3	03/19/96
4	P A T	DAW 100	BENDING PLATES	3	2	03/19/96
4	P A T	DAW 100	PIEZO	6	2	03/19/96
4	P A T	DAW 200	BENDING PLATES	150	44	03/19/96
3	PEEK	AVC 3000	LOOPS/PIEZO	31	12	09/08/94
2	PEEK	VC 1900	LOOPS/TUBES	844	0	09/08/94
2	PEEK TRAFFIC	TRAFICOMP II	LOOPS	8	8	09/08/94
2	PEEK TRAFFIC	TRAFICOMP III	LOOPS	25	25	09/08/94
3	PEEK TRAFFIC	TRAFICOMP III	LOOP/TUBE/PIEZO	163	0	09/08/94
1	SARASOTA	VC1900	LOOPS	15	0	09/08/94
2	TRAFFIC DETECTOR SYSTEMS	TLS	LOOP	127	127	09/08/94

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
** State: CO						
2	GOLDEN RIVER	MARKSMAN	LOOPS	55	55	09/28/94
1	GOLDEN RIVER	MARKSMAN	LOOPS	55	55	09/28/94
4	GOLDEN RIVER	WEIGHMAN	LOOPS	5	90	09/28/94
1	I R D		LOOPS/PIEZO	15	15	09/28/94
2	I R D		LOOPS/PIEZO	15	15	09/28/94
3	I R D		LOOPS/PIEZO	15	15	09/28/94
** State: CT						
2	DIAMOND	UNICORN 502	TUBES/LOOPS	150	5500	03/19/96
3	DIAMOND	UNICORN 502	LOOPS/TUBES	150	70	03/19/96
4	I R D	1060P	PIEZO	1	5	03/19/96
4	MIKROS	TEL-2CM	PIEZO	2	90	03/19/96
4	STREETER AMET	5150	CAP. MAT	1	90	03/19/96
2	STREETER AMET	TRAFICOMP III	LOOPS	49	38	03/19/96
1	STREETER RICHARDSON	140	LOOPS	2	0	08/26/94
1	STREETER RICHARDSON	141-4	LOOPS	3	25	08/26/94
1	STREETER RICHARDSON	141A-4	LOOPS	1	0	08/26/94
** State: DC						
2	GOLDEN RIVER	GR0331	LOOPS/HOSE	39	31	03/10/89
2	GOLDEN RIVER	GR0331	TUBE	54	600	03/10/89
1	M.P.H. INDUS.	K-55	DOPLLER/RADAR	2	50	03/10/89
** State: DE						
4	P A T	DAW 400	BENDING PLATE	1	1	08/26/94
1	STREETER RICHARDSON	141A	TUBES	125	50	03/19/96
2	STREETER RICHARDSON	141A	TUBES	125	50	03/19/96
3	STREETER RICHARDSON	141A	TUBES	125	50	03/19/96
** State: FL						
2	DIAMOND	PHOENIX	PIEZO	1	1	03/19/96
3	DIAMOND	PHOENIX	PIEZO	1	1	03/19/96
3	DIAMOND	TT 2001	LOOPS/PIEZO	50	50	03/19/96
2	DIAMOND	TT 2001	PIEZO	15	15	03/19/96
1	P A T	AVC-100	LOOPS/PIEZO	5	5	03/19/96
3	P A T	AVC-100	LOOPS/PIEZO	10	10	03/19/96
1	P A T	AVC-100	PIEZO	3	3	03/19/96
3	P A T	C 100 S	LOOPS/PIEZO	1	1	03/19/96
3	P A T	C 100 S	LOOPS/PIEZO	6	6	03/19/96
1	P A T	C-100 S	LOOPS/PIEZO	26	26	03/19/96
1	P A T	C-100 S	PIEZO	3	3	03/19/96
1	P A T	C-100 S	PIEZO	46	44	03/19/96
4	P A T	DAW 100	PIEZO	8	8	03/19/96
4	P A T	DAW 200	BENDING PLATES	3	3	03/19/96
4	P A T	DAW 200	BENDING PLATES	9	9	03/19/96
3	PEEK	ADR-3000	PIEZO	16	12	03/19/96

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
1	SARASOTA	VC 1900	LOOPS	14	14	03/19/96
2	SARASOTA	VC 1900	LOOPS	16	16	03/19/96
3	STREETER RICHARDSON	TC 241 III	LOOPS/PIEZO	7	4	03/19/96
1	STREETER RICHARDSON	TC 241 III	LOOPS/PIEZO	4	4	03/19/96
* State: GA						
4	BRIDGE WEIGHING SYSTEMS	BRIDGEMATE	PIEZO	2	16	09/08/94
4	I R D	1060	LOOPS/PIEZO	2	2	09/08/94
2	STREETER AMET	241	TUBES	257	0	11/21/92
2	STREETER AMET	241	LOOPS/PIEZO	174	0	09/08/94
2	STREETER AMET	JR	TUBES	347	0	09/08/94
2	STREETER AMET	MR	TUBES	105	0	09/08/94
3	STREETER RICHARDSON	241	TUBES	408	0	09/08/94
3	STREETER RICHARDSON	241	LOOPS/PIEZO	174	0	09/08/94
* State: HI						
4	I R D	1060 P	Piezo/Loops	3	3	08/25/94
2	I R D	TC/C 530	LOOPS	24	12	08/25/94
4	PAT	DAW 200	Bending Plate	1	1	08/25/94
4	PAT	DAW 400	Twin Bending Pl	1	1	08/25/94
2	STREETER RICHARDSON	TC II	Loops/Tubes	12	20	08/25/94
1	STREETER RICHARDSON	TC II - 141	Loops	10	8	08/25/94
1	STREETER RICHARDSON	TC II - 141	Loops	2	2	08/25/94
2	STREETER RICHARDSON	TC III - 241	LOOPS/TUBES	30	500	08/25/94
* State: IA						
4	G K INSTRUMENTS	6000	PIEZO / LOOPS	21	20	03/20/96
4	P A T		BENDING PLATES	2	2	03/20/96
1	PEEK	TELAC	LOOPS	107	80	03/20/96
2	PEEK	TELAC	LOOPS	107	80	03/20/96
3	PEEK	TRAFICOMP III	TUBES	264	10000	03/20/96
1	PEEK	TRAFICOMP III	LOOPS & PIEZO	52	42	03/20/96
2	PEEK	TRAFICOMP III	LOOPS & PIEZO	52	36	03/20/96
1	PEEK	TRAFICOMP III	TUBES	240	10000	03/20/96
* State: ID						
1	DIAMOND	2001	Loops	33	28	08/31/94
2	DIAMOND	2001	LOOPS	20	20	03/20/96
2	DIAMOND	2001	LOOPS	18	18	03/20/96
2	DIAMOND	2001	TUBES	8	8	03/20/96
2	DIAMOND	501	LOOPS	2	2	03/20/96
2	DIAMOND	501	TUBES	3	3	03/20/96
3	DIAMOND	501	TUBES	20	30	03/20/96
2	DIAMOND	PHOENIX	LOOPS	7	7	03/20/96
2	DIAMOND	PHOENIX	LOOPS	32	32	03/20/96
1	DIAMOND	T 2001	Tubes	13	0	08/31/94

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
3	DIAMOND	UNICORN	TUBES	80	120	03/20/96
2	DIAMOND	UNICORN	LOOPS	4	4	03/20/96
2	DIAMOND	UNICORN	LOOPS	5	5	03/20/96
4	E C M	HESTIA	PIEZO	40	13	03/20/96
2	GOLDEN RIVER	331	LOOPS	12	12	03/20/96
2	GOLDEN RIVER	331	LOOPS	5	5	03/20/96
1	GOLDEN RIVER	340	Loops	19	16	08/31/94
2	GOLDEN RIVER	340	LOOPS	7	7	03/20/96
2	GOLDEN RIVER	340	LOOPS	6	6	03/20/96
1	GOLDEN RIVER	382	Loops	22	18	08/31/94
2	GOLDEN RIVER	382	LOOPS	9	9	03/20/96
2	GOLDEN RIVER	382	LOOPS	4	4	03/20/96
1	GOLDEN RIVER	660	LOOP	21	21	08/31/94
1	GOLDEN RIVER	6601	Tubes	75	0	08/31/94
4	GOLDEN RIVER	WEIGHMAN 3081	CAP. MAT	6	80	03/20/96
** State: IL						
1	PEEK	241	LOOPS	79	79	03/20/96
3	PEEK	241	PIEZO	21	21	03/20/96
2	PEEK	241	PIEZO	21	21	03/20/96
2	PEEK	241	LOOPS	28	28	03/20/96
4	PEEK	GK 6000	PIEZO/LOOPS	20	17	03/20/96
** State: IN						
4	I R D	1060P	DYNAX,PIEZO,BP	37	33	03/20/96
2	PEEK	TELAC 505C-2	LOOPS	78	61	03/20/96
2	PEEK	TRAFICOMP III	TUBES	242	21000	03/20/96
3	PEEK	TRAFICOMP III	TUBES & PIEZO	242	300	03/20/96
1	PEEK	TRAFICOMP III	LOOPS & TUBES	46	14	03/20/96
** State: KS						
4	AVIAR	TDL-500	CAP. MAT	3	75	03/20/96
1	DIAMOND	TT 2001	LOOPS	110	96	03/20/96
2	DIAMOND	TT 2001	LOOPS	110	96	03/20/96
4	G K INSTRUMENTS	6700	PIEZO CABLE	19	16	03/20/96
4	I R D	1060	BENDING PLATE	1	1	03/20/96
3	PEEK	TRAFICOMP III	TUBES	12	500	03/20/96
4	TOLEDO SCALE	HSWD 4	LOAD CELLS	1	1	08/26/94
** State: KY						
4	GOLDEN RIVER	GR 3081	CAP. MAT	5	80	03/20/96
4	GOLDEN RIVER	GR 36	CAP. STRIPS	1	1	03/20/96
4	I R D	1060	Bending Plate	4	4	03/20/96
4	I R D	1060P	PIEZO	5	2	03/20/96
4	P A T	DAW 200	BENDING PLATE	1	1	03/20/96
4	PEEK	GK 6000	PIEZO	1	1	03/20/96
3	PEEK	TRAFICOMP III	TUBES & PIEZO	75	2000	03/20/96

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
2	PEEK	TRAFICOMP III	Loops	40	40	03/20/96
2	PEEK	TRAFICOMP III	LOOPS & TUBES	429	15000	03/20/96
3	PEEK	TRAFICOMP III	PIEZO	21	21	03/20/96
1	STREETER RICHARDSON	141-A	LOOP	6	35	08/31/94
1	STREETER RICHARDSON	141-A4	LOOP	2	0	08/31/94
1	STREETER RICHARDSON	TC II - 141A-4	Loops	8	35	08/31/94
4	TOLEDO	BRIDGEMATE	PIEZO	1	1	03/20/96
4	TOLEDO	BRIDGEMATE 655	TUBES	4	5	03/20/96
** State: LA						
2	I R D	TCC 530	TUBES & LOOPS	30	0	03/20/96
3	I R D	TCC 530	LOOPS & TUBES	30	0	03/20/96
4	I R D	WIM	PIEZO	1	1	03/20/96
4	P A T	DAW 200P	CAP. MAT	4	30	03/20/96
1	PEEK	TRAFICOMP III	TUBES	10	0	03/20/96
2	PEEK	TRAFICOMP III	TUBE/LOOP/PIEZO	60	60	03/20/96
3	PEEK	TRAFICOMP III	TUBES	25	700	03/20/96
** State: MA						
4	AVIAR	TDL 500	CAP. MATS	8	90	08/26/94
4	E C M	HESTIA	PIEZO	2	2	03/27/96
4	I R D		PIEZO	6	6	03/27/96
1	PEEK	TRAFICOMP III	TUBES/LOOPS	739	30	03/27/96
2	PEEK	TRAFICOMP III	TUBES/LOOPS	739	2500	03/27/96
3	PEEK	TRAFICOMP III	TUBES/LOOPS	739	300	03/27/96
** State: MD						
4	BRIDGE WEIGHING SYSTEMS			1	0	09/30/85
2	SARATEC	241	LOOPS	40	40	11/21/92
1	SARATEC	241	LOPP/TUBE/PIEZO	29	29	11/21/92
1	SARATEC	241	TUBE/LOOP/PIEZO	1	1	11/21/92
3	SARATEC	241	TUBES/PIEZO	275	0	11/21/92
** State: ME						
4	I R D		PIEZO	3	8	11/21/92
4	I R D	WIM 4	HYD. LOAD CELLS	1	1	09/28/94
3	I T C	TRAFFIC ACE	TUBES	40	2400	03/27/96
1	I T C	TRAFFIC ACE	TUBES	40	2400	03/27/96
2	I T C	TRAFFIC ACE	TUBES	40	2400	03/27/96
1	PEEK	GK 5000	TUBES	40	2400	03/27/96
2	PEEK	GK 5000	TUBES	40	2400	03/27/96
3	PEEK	GK 5000	TUBES	40	2400	03/27/96
2	PEEK	TRAFICOMP III	LOOP	115	45	03/27/96
** State: MI						
3	DIAMOND	PHOENIX & TALLY	DYNAX & PIEZO	51	50	03/20/96

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
1	DIAMOND	PHOENIX & TALLY	DYNAX & PIEZO	51	50	03/20/96
2	DIAMOND	PHOENIX & TALLY	DYNAX & PIEZO	51	50	03/20/96
4	I R D		BENDING PLATE	4	4	03/20/96
4	P A T	CC 200	PIEZO	10	15	03/20/96
1	PEEK	ADR	PIEZO	1	1	03/20/96
2	PEEK	ADR	PIEZO	1	1	03/20/96
3	PEEK	ADR	PIEZO	1	1	03/20/96
3	SARASOTA	VC 1900	LOOPS	556	58	03/20/96
** State: MN						
3	DIAMOND	TT 2001	TUBES	10	100	03/20/96
2	GOLDEN RIVER	3031	TUBES & LOOPS	70	0	03/20/96
4	I R D	1060	BENDING PLATE	18	18	03/20/96
4	I R D	1060	PIEZO	2	2	03/20/96
4	I R D	1060	LOAD CELLS	5	5	03/20/96
3	I R D	TCC-510 4R	Tubes	10	100	03/20/96
2	JAMAR	IMC IV	MANUAL	10	0	03/20/96
2	PEEK	160-2	TUBES	850	0	03/20/96
2	PEEK	163-1	TUBES	100	0	03/20/96
2	PEEK	MR	TUBES	75	0	03/20/96
3	STREETER AMET	241	TUBES	7	50	03/20/96
1	STREETER RICHARDSON	505C	LOOP	15	15	03/20/96
2	STREETER RICHARDSON	TELAC	LOOP	100	100	03/20/96
** State: MO						
4	G K INSTRUMENTS	AWACS 6000	LOOPS/PIEZO	2	8	08/26/94
4	GOLDEN RIVER	3081	CAP. MAT/TUBES	3	72	08/26/94
1	GOLDEN RIVER	3082	LOOPS	14	11	08/26/94
2	GOLDEN RIVER	331 & 334	LOOP	94	72	08/26/94
4	I R D	1060 HP	BENDING PLATE	2	2	08/26/94
4	I R D	1060HP	LOOPS/PIEZO	9	8	08/26/94
1	STREETER AMET	241	TUBES	6	13	08/26/94
1	STREETER AMET	241	LOOPS	16	7	08/26/94
3	STREETER RICHARDSON	241	LOOPS/PIEZO	18	8	08/26/94
** State: MS						
1	MITRON	3000	TUBES/PIEZO	4	0	03/20/96
3	MITRON	3000	TUBES	4	0	03/20/96
4	P A T	DAW 100	BENDING PLATES	1	1	03/20/96
4	P A T	DAW 100	PIEZO	20	20	03/20/96
4	P A T	DAW 200	LOOPS/ MAT	2	90	03/20/96
3	STREETER RICHARDSON	141A	TUBES	30	0	03/20/96
2	STREETER RICHARDSON	505	LOOP	55	43	03/20/96
4	TOLEDO		LOAD CELL	1	1	03/20/96
** State: MT						
2	DIAMOND	TT 2001	PIEZO	6	6	09/28/94

State Traffic Monitoring Equipment
1 = Speed, 2 = Volume, 3 = Class, 4= Weight

Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
3	DIAMOND	TT 2001	PIEZO	6	6	09/28/94
1	DIAMOND	TT 2001	PIEZO	4	4	09/28/94
4	E C M	HESTIA	CAP. MAT/PIEZO	1	2	09/28/94
2	GOLDEN RIVER	340		5	5	09/28/94
2	PEEK	MR		5	5	09/28/94
1	PEEK	TC-III 241		34	34	09/28/94
2	PEEK	TC-III 241		48	48	09/28/94
2	PEEK	TC-III 241	PIEZO	2	2	09/28/94
1	PEEK	TC-III 241	TUBES	1	1	09/28/94
3	PEEK	TC-III 241	PIEZO	2	2	09/28/94
** State: NC						
2	DIAMOND TRAFFIC	TT 2001	LOOPS/TUBES	114	105	08/26/94
4	P A T	DAW 100	LOOPS/PIEZO	2	23	11/22/92
3	STREETER RICHARDSON	141A-2	ROAD TUBE	8	70	09/18/86
3	STREETER RICHARDSON	141A-4	ROAD TUBE/LOOP	3	70	09/18/86
1	STREETER RICHARDSON	TC III, 241	ROAD TUBE/LOOP	32	37	08/26/94
3	STREETER RICHARDSON	TC III, 241	LOOPS/TUBES	32	300	08/26/94
** State: ND						
4	PEEK TRAFFIC	GK 6000	PIEZO	5	5	12/10/92
2	PEEK TRAFFIC	GK 6000	PIEZO	5	5	08/26/94
3	PEEK TRAFFIC	GK 6000	PIEZO	5	5	08/26/94
3	PEEK TRAFFIC	GK 6000	PIEZO	1	1	08/26/94
3	PEEK TRAFFIC	TC 241 EZ	TUBES	20	500	08/26/94
1	STREETER RICHARDSON	241 TC-III	ROAD TUBE	62	21	08/26/94
3	STREETER RICHARDSON	241 TC-III	TUBES	42	900	08/26/94
3	STREETER RICHARDSON	241 TC-III	PIEZO	5	5	08/26/94
2	STREETER RICHARDSON	505-C	LOOPS	43	43	08/26/94
1	STREETER RICHARDSON	505-C	LOOPS	43	12	08/26/94
4	STREETER RICHARDSON	5150XT	CAP. MAT	2	90	12/10/92
** State: NE						
2	DIAMOND	TT 2001	LOOPS	25	24	03/20/96
3	DIAMOND	TT 2001	LOOPS/PIEZO	16	15	03/20/96
2	DIAMOND	UNICORN	LOOP	25	24	03/20/96
4	GOLDEN RIVER	WEIGHMAN	CAP. MAT	14	33	03/20/96
1	SARASOTA	VC 1900	LOOPS	4	40	08/31/94
** State: NH						
1	G K INSTRUMENTS	6000	LOOPS	5	30	08/26/94
3	G K INSTRUMENTS	GK 5000	LOOPS	130	300	03/23/96
2	G K INSTRUMENTS	GK 6000	LOOPS & TUBES	130	0	03/23/96
2	GK INSTRUMENTS	GK 5000	TUBES & LOOPS	130	0	03/23/96
4	I R D	HYD. LOAD CELLS		1	1	03/23/96

State Traffic Monitoring Equipment
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Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
** State: NJ						
4	BRIDGE WEIGH SYSTEMS		STRAIN GAUGES	1	7	08/26/94
3	GOLDEN RIVER		LOOPS/SENSORS	4	0	08/26/94
3	GOLDEN RIVER	ARCHER	TUBES	13	0	08/26/94
2	GOLDEN RIVER	MARKSMAN 3031	LOOPS/TUBES	150	57	08/26/94
4	I R D	1060P	PIEZO	12	10	08/26/94
4	P A T	DAW 200	CAP. MAT	1	0	08/26/94
1	STREETER RICHARDSON	140 A	LOOPS	10	29	11/22/92
1	STREETER RICHARDSON	241	LOOPS/TUBES	24	29	08/26/94
** State: NM						
4	I D C	TEL-2CM	PIEZO	2	2	03/23/96
4	PEEK TRAFFIC	5150XT	CAP. MAT	2	43	03/23/96
1	PEEK TRAFFIC	TRAFICOMP III	LOOPS	70	70	03/23/96
2	PEEK TRAFFIC	TRAFICOMP III	TUBES	90	1600	03/23/96
1	PEEK TRAFFIC	TRAFICOMP III	TUBES	14	14	03/23/96
2	PEEK TRAFFIC	TRAFICOMP III	LOOPS	130	100	03/23/96
** State: NV						
3	DIAMOND	PHOENIX	PIEZO & LOOPS	34	34	03/20/96
3	DIAMOND	TT 2001	TUBES	24	100	03/20/96
2	DIAMOND	TT 2001	LOOPS	4	4	03/20/96
2	DIAMOND	UNICORN	LOOPS	1	1	03/20/96
2	GOLDEN RIVER	3031	LOOPS	35	37	03/20/96
2	GOLDEN RIVER	334	LOOPS	14	14	03/20/96
2	GOLDEN RIVER	340	LOOPS	10	0	03/20/96
2	GOLDEN RIVER	382	LOOPS	2	0	03/20/96
1	GOLDEN RIVER	GR 0340	LOOPS	10	39	03/20/96
1	GOLDEN RIVER	GR 0382	LOOPS	4	39	03/20/96
1	GOLDEN RIVER	GR 660	LOOPS	2	39	03/20/96
1	KUSTOM SIGNALS	PRO-LASER	LIDAR	1	0	03/20/96
1	NU-METRICS	HI-STAR NC-90A	MAGNETOMETER	2	0	03/20/96
2	NU-METRICS	HI-STAR NC-90A	MAGNETOMETER	2	0	03/20/96
4	P A T	DAW 100	BENDING PLATE	2	2	03/20/96
4	P A T	DAW 190	CAP. MAT	3	88	03/20/96
4	STREETER RICHARDSON	5150XTP	CAP. MAT	1	0	03/20/96
** State: NY						
1	DIAMOND TRAFFIC	Tally 2001	Tube/Loop	150	0	09/08/94
2	DIAMOND TRAFFIC	Tally 2001	Tube/Loop	150	0	09/08/94
3	DIAMOND TRAFFIC	Tally 2001	Tube/Loop	150	0	09/08/94
2	G K INSTRUMENTS	5000	TUBES	30	0	09/08/94
1	G K INSTRUMENTS	5000	Tube	30	0	09/08/94
3	G K INSTRUMENTS	5000	Tube	30	0	09/08/94
2	G K INSTRUMENTS	6000	LOOPS/TUBES	235	8000	09/08/94
1	G K INSTRUMENTS	6000	Tubes/Loops	235	8000	09/08/94
3	G K INSTRUMENTS	6000	Tubes/Loops	235	8000	09/08/94

State Traffic Monitoring Equipment
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Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
2	G K INSTRUMENTS	6000	Loop	55	55	09/08/94
1	GOLDEN RIVER	328 & 340	LOOPS	28	0	09/08/94
2	GOLDEN RIVER	340 & 341	LOOPS	10	10	09/08/94
4	I R D		BENDING PLATES	7	7	03/23/96
3	I R D	TCC 530	LOOP/TUBE/Dynax	5	4	09/08/94
3	JAMAR	TDC 8 & DB 400	Visual	14	0	09/08/94
4	MIKROS		PIEZO	1	1	03/23/96
4	P A T	DAW 100	BENDING PLATES	3	3	03/23/96
2	PEEK TRAFFIC	241	Loop/Piezo	80	80	03/23/96
1	STREETER AMET	241	Loop/Piezo	90	80	09/08/94
3	STREETER AMET	241	Loops/Piezo	90	80	09/08/94
** State: OH						
4	I R D		PIEZO	2	2	03/23/96
4	NORTH LINE	MARKSMAN 660	CAP. STRIPS	1	1	03/23/96
4	P A T	DAW 100	PIEZO	1	1	03/23/96
4	P A T	DAW 200	BENDING PLATES	6	6	03/23/96
3	PEEK	TRAFICOMP 241	PIEZO	30	25	03/23/96
1	PEEK TRAFFIC	141 & 241	LOOPS	30	59	03/23/96
2	PEEK TRAFFIC	241	LOOPS	100	208	03/23/96
4	PEEK TRAFFIC	GK 6000	PIEZO	1	1	03/23/96
4	TOLEDO SCALE	LOAD CELL	PIEZO	11	11	03/23/96
** State: OK						
2	DIAMOND	PHOENIX	LOOPS	35	35	03/23/96
1	DIAMOND	T 2001	LOOPS	3	27	11/22/92
4	I R D	1060P	PIEZO	24	24	03/23/96
1	LEUPOLD-STEVENS		LOOPS	1	9	11/22/92
3	PEEK TRAFFIC	241	LOOPS/PIEZO	18	18	03/23/96
2	T D S	DPC824	LOOP	47	47	11/22/92
** State: OR						
3	DIAMOND	T 2001	TUBES	75	0	08/26/94
3	DIAMOND	T 2001	PIEZO	2	1	08/26/94
4	I R D		HYD. LOAD CELLS	6	2	08/26/94
4	I R D		DYNAX	1	2	08/26/94
4	I R D		BENDING PLATE	1	1	08/26/94
3	I R D	AS 400	DYNAX/LOOPS	6	1	03/23/96
4	I R D	BENDING PLATES	DYNAX SENSORS	4	1	03/23/96
4	I R D	LOAD CELL	DYNAX SENSORS	15	13	03/23/96
4	I R D	PIEZO	DYNAX SENSORS	6	1	03/23/96
3	JAMAR	TDC-8	VISUAL	18	0	08/26/94
3	P A T		PIEZO	12	12	03/23/96
1	STREETER RICHARDSON	241	LOOPS	41	41	03/23/96
2	STREETER RICHARDSON	TRAFICOMP III	LOOPS	128	123	03/23/96
3	STREETER RICHARDSON	TRAFICOMP III	DYNAX SENSORS	8	4	03/23/96

State Traffic Monitoring Equipment
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Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
** State: PA						
2	DIAMOND	PHOENIX	LOOPS	63	63	03/23/96
1	DIAMOND	PHOENIX	LOOPS	63	63	03/23/96
3	DIAMOND	PHOENIX	LOOPS	63	63	03/23/96
3	GK INSTRUMENTS	5000	TUBES	50	0	09/08/94
3	GK INSTRUMENTS	6000	TUBES	65	0	09/08/94
2	GK INSTRUMENTS	GK 5000	TUBES	50	0	03/23/96
2	GK INSTRUMENTS	GK 6000	TUBES	59	0	03/23/96
4	GOLDEN RIVER	WEIGHMAN	CAP. MAT	4	21	03/23/96
4	I R D	HYD. LOAD CELL	LOOPS	1	1	09/08/94
4	I R D	HYD. LOAD CELLS	ALL	2	2	09/08/94
2	NU-METRICS	NC-90	MAGNETOMETER	42	0	03/23/96
4	P A T	DAW 200	BENDING PLATE	1	1	03/23/96
1	P A T	DAW 200	BENDING PLATE	1	1	03/23/96
3	P A T	DAW 200	BENDING PLATES	1	1	03/23/96
4	P A T	DAW 300	ALL	6	6	09/08/94
4	P A T	DAW 400	BENDING PLATE	22	22	09/08/94
2	STREETER RICHARDSON	141	TUBES	80	0	03/23/96
3	STREETER RICHARDSON	141-A	TUBES	131	2000	09/08/94
1	STREETER RICHARDSON	241	TUBES & PIEZO	172	0	03/23/96
2	STREETER RICHARDSON	241	PIEZO & TUBES	172	0	03/23/96
3	STREETER RICHARDSON	241	TUBES & PIEZO	172	0	03/23/96
2	STREETER RICHARDSON	505	LOOPS	67	60	03/23/96
2	STREETER RICHARDSON	MR	TUBES	83	0	03/23/96
** State: RI						
4	I R D	1060P	PIEZO	1	1	11/22/92
1	STREETER RICHARDSON	241	LOOP	13	13	08/25/94
2	STREETER RICHARDSON	241	TUBE/LOOP	75	35	08/25/94
3	STREETER RICHARDSON	241	TUBES	47	0	08/25/94
3	STREETER RICHARDSON	241	LOOPS	3	3	08/25/94
4	TRUVELO	TDL/500	CAP. MAT	2	0	08/25/94
** State: SC						
4	I R D		BENDING PLATES	2	2	08/26/94
4	INTERNATIONAL TRAFFIC	TEL-2CM	CAP. MAT	1	39	03/23/96
4	P A T	DAW 100 PI	PIEZO	1	1	03/23/96
4	P A T	DAW 100 WP	BENDING PLATE	2	2	03/23/96
4	P A T	DAW 200	CAP. MAT/LOOPS	1	13	08/26/94
4	P A T	DAW 200	BENDING PLATES	3	3	03/23/96
4	P A T	DAW 200P	CAP. MAT	4	39	03/23/96
1	PEEK	TRAFICOMP III	TUBES	8	40	03/23/96
2	PEEK	TRAFICOMP III	LOOPS & PIEZO	49	45	03/23/96
3	PEEK	TRAFICOMP III	TUBES & LOOPS	50	300	03/23/96
4	TOLEDO		LOAD CELL	4	2	03/23/96

State Traffic Monitoring Equipment
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Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
** State: SD						
4	I R D		BENDING PLATE	1	1	08/31/94
4	P A T	DAW 100	PIEZO	2	2	08/31/94
4	P A T	DAW 200	BENDING PLATE	1	1	08/31/94
4	STATE DEVELOPED	BRIDGE WIM	PIEZO	6	6	08/31/94
1	STREETER RICHARDSON	TRAFICOMP	TUBES	120	100	08/31/94
2	STREETER RICHARDSON	TRAFIÇOMP III	LOOPS/PROBES	49	48	08/31/94
3	STREETER RICHARDSON	TRAFICOMP III	TUBES	120	100	08/31/94
** State: TN						
2	DIAMOND	Unicorn	Tubes	24	35	03/25/96
3	DIAMOND	Unicorn	Tubes	24	0	08/25/94
2	I R D	TCC 510	TUBES/LOOPS	20	1600	08/25/94
1	I R D	TCC 520	TUBES & LOOPS	4	27	03/25/96
4	P A T	DAW 100	LOOPS/PIEZO	12	12	03/25/96
3	STREETER AMET	141-A4	TUBES	23	200	03/25/96
2	STREETER RICHARDSON	141-4	TUBES	162	1800	03/25/96
2	STREETER RICHARDSON	TELAC 505-C	LOOPS	40	33	03/25/96
4	TRUVELO	TDL/500	CAP. MAT	2	90	03/25/96
** State: TX						
4	AVIAR - TRUVELO	TDL 500	CAP. MAT	4	0	03/25/96
4	E C M	Hestia (Port.)	Loops/Piezo	15	39	03/25/96
4	P A T	DAW 100	BENDING PLATE	5	10	03/25/96
4	P A T	DAW 200	BENDING PLATES	5	15	03/25/96
1	PEEK	TC III - 241	LOOPS & TUBES	35	44	03/25/96
2	PEEK	TC III - 241	LOOPS	200	145	03/25/96
3	PEEK	TC III - 241	LOOP/TUBE/PIEZO	100	530	03/25/96
** State: UT						
4	GOLDEN RIVER	WEIGHMAN	CAP. MAT	4	100	03/25/96
1	PEEK	261	LOOPS & PIEZO	14	14	03/25/96
3	PEEK	261	LOOP	68	68	03/25/96
2	PEEK	261	LOOPS & PIEZO	14	14	03/25/96
3	PEEK	261	LOOPS & PIEZO	14	14	03/25/96
2	PEEK	560	LOOP	68	68	03/25/96
1	PEEK	560	LOOPS	68	68	03/25/96
3	STREETER-RICHARDSON	141	Hoses, Loops	75	75	08/31/94
** State: VA						
3	DIAMOND	T 2001	TUBE/LOOP/PIEZO	6	0	08/25/94
4	I R D		LOOPS & PIEZO	13	15	03/25/96
4	P A T		BENDING PLATES	2	1	08/25/94
2	STREETER AMET	141	TUBES& LOOPS	82	5000	03/25/96
3	STREETER AMET	141	TUBES	43	225	03/25/96
2	STREETER AMET	141-A	TUBES	43	225	03/25/96
1	STREETER AMET	241	LOOPS	43	43	03/25/96

State Traffic Monitoring Equipment
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Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
2	STREETER AMET	241	TUBES & LOOPS	431	956	03/25/96
3	STREETER AMET	241	LOOPS	169	169	03/25/96
** State: VT						
1	G K INSTRUMENTS	6000	LOOPS/TUBES	20	0	08/25/94
2	G K INSTRUMENTS	6000	LOOPS	70	55	08/25/94
3	G K INSTRUMENTS	6000	TUBES	80	0	08/25/94
3	I R D		Tubes/Loops	5	2	08/25/94
4	I R D	1060	PIEZO	10	10	08/25/94
** State: WA						
1	DIAMOND	T-2001	Loops	8	33	08/25/94
1	I R D	1060	Piezo/Dynax/BP	42	42	03/25/96
2	I R D	1060	Piezo/Dynax/BP	53	53	03/25/96
4	I R D	1060	PIEZO & BP	42	42	03/25/96
3	I R D	1060	Piezo/Dynax/BP	53	53	03/25/96
** State: WI						
1	APPLIED CONCEPTS	STALKER	RADAR	2	0	03/25/96
4	C M I		HYD. LOAD CELL	1	1	03/25/96
1	DECATUR	GENESIS	RADAR	22	0	03/25/96
1	DECATUR	KN-1	RADAR	27	0	03/25/96
4	HOWE RICHARDSON	5150SE	PIEZO STRIPS	2	2	03/25/96
4	I R D		LOOPS & PIEZO	1	1	03/25/96
4	I R D		LOOPS & DYNAX	2	1	03/25/96
4	I R D	DD 200	BENDING PLATE	1	1	08/26/94
1	KUSTOM	FALCON	RADAR	36	0	03/25/96
1	KUSTOM	HAWK	RADAR	16	0	03/25/96
1	KUSTOM	KR-10	RADAR	196	0	03/25/96
1	KUSTOM	PRO-1000	RADAR	56	0	03/25/96
1	KUSTOM	PRO-LASER	LASER	4	0	03/25/96
1	LASER TECHNOLOGY	LTI 20-20	LASER	7	0	03/25/96
4	P A T	DAW 100	BENDING PLATE	2	2	08/26/94
4	P A T	DAW 200	CAP. MAT	4	70	08/26/94
4	STREETER		LOOPS & PIEZO	1	1	03/25/96
4	STREETER AMET	5150XT	LOAD CELL	1	1	08/26/94
1	STREETER RICHARDSON	241	TUBE/LOOP/PIEZO	167	77	08/26/94
2	STREETER RICHARDSON	241	TUBE/LOOP/PIEZO	167	105	08/26/94
3	STREETER RICHARDSON	241	LOOP/TUBE/PIEZO	999	450	08/26/94
1	TRAFFIC SAFETY SYSTEMS	VASCAR PLUS		215	0	03/25/96
** State: WV						
3	P A T	AVC 100	LOOPS& PIEZO	47	47	03/25/96
4	P A T	DAW 200	BENDING PLATE	4	4	03/25/96
1	PEEK	TRAFICOMP III	Tubes	30	32	09/14/94
2	PEEK	TRAFICOMP III	TUBES	150	2000	03/25/96
3	PEEK	TRAFICOMP III	TUBES	20	35	09/14/94

State Traffic Monitoring Equipment
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Type	Manufacturer	Model	Sensor	No. of Units	No. of Sites	Updated
* State: WY						
3	DIAMOND	TT2001& PHOENIX	LOOPS & PIEZO	234	13	03/25/96
2	DIAMOND	TT2001& PHOENIX	LOOPS	234	68	03/25/96
1	DIAMOND TRAFFIC	TT2001& PHOENIX	LOOPS	254	35	03/25/96
4	I R D	Hydraulic		4	3	08/31/94
2	NU-METRICS	Count Card	None	10	0	08/31/94
1	NU-METRICS	Hi-Star	None	20	0	08/31/94
4	P A T	DAW 100	PIEZO	1	1	03/25/96
4	P A T	DAW 200	CAP. MAT	1	12	03/25/96
2	SAFETRAN	DPC-824	LOOP	80	25	08/31/94

STATE TRAFFIC MONITORING EQUIPMENT CONTACTS

Office of Information Management

Presented at
National Traffic Data Acquisition Conference
Albuquerque, New Mexico

May 5-9, 1996

Traffic Monitoring Equipment Contacts
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State	Type	Name	Telephone	Updated
AK	1	BEV FANTAZZI	(907)451-2252	04/15/96
AK	2	BEV FANTAZZI	(907)451-2252	04/15/96
AK	3	BEV FANTAZZI	(907)451-2252	04/15/96
AK	4	BEV FANTAZZI	(907)451-2252	04/15/96
AK	1	CHRIS PAYTON	(907)465-4496	04/15/96
AK	2	CHRIS PAYTON	(907)465-4496	04/15/96
AK	3	CHRIS PAYTON	(907)465-4496	04/15/96
AK	4	CHRIS PAYTON	(907)465-4496	04/15/96
AK	1	DOUG TERHUNE	(907)266-1618	04/15/96
AK	2	DOUG TERHUNE	(907)266-1618	04/15/96
AK	3	DOUG TERHUNE	(907)266-1618	04/15/96
AK	4	DOUG TERHUNE	(907)266-1618	04/15/96
AK	1	MARY ANN DIERCKMAN	(907)465-6993	04/15/96
AK	2	MARY ANN DIERCKMAN	(907)465-6993	04/15/96
AK	3	MARY ANN DIERCKMAN	(907)465-6993	04/15/96
AK	4	MARY ANN DIERCKMAN	(907)465-6993	04/15/96
AL	1	CHARLES W. TURNEY	(205)242-6393	09/08/94
AL	2	CHARLES W. TURNEY	(205)242-6393	09/08/94
AL	3	CHARLES W. TURNEY	(205)242-6393	09/08/94
AL	4	CHARLES W. TURNEY	(205)242-6393	09/08/94
AR	1	SCOTT E. BENNETT	(501)569-2111	03/19/96
AR	2	SCOTT E. BENNETT	(501)569-2111	03/19/96
AR	3	SCOTT E. BENNETT	(501)569-2111	03/19/96
AR	4	SCOTT E. BENNETT	(501)569-2111	03/19/96
AZ	1	R. PIKE	(602)255-8228	10/26/94
AZ	2	R. PIKE	(602)255-8228	10/26/94
AZ	3	R. PIKE	(602)255-8228	10/26/94
AZ	4	R. PIKE	(602)255-8228	10/26/94
CA	1	JOE AVIS	(916)654-3072	09/08/94
CA	2	JOE AVIS	(916)654-3072	09/08/94
CA	3	JOE AVIS	(916)654-3072	09/08/94
CA	4	KONEY ARCHULETA	(916)654-7375	10/26/94
CA	4	RICH QUINLEY	(916)654-5651	03/19/96
CO	1	ROBERT SAKAGUCHI	(303)757-9818	09/28/94
CO	2	ROBERT SAKAGUCHI	(303)757-9818	09/28/94
CO	3	ROBERT SAKAGUCHI	(303)757-9818	09/28/94
CO	4	ROBERT SAKAGUCHI	(303)757-9818	09/28/94
CT	2	JOE CRISTALLI	(203)594-2091	03/19/96
CT	3	JOE CRISTALLI	(203)594-2091	03/19/96
CT	2	SAGAN H. FERRI	(203)594-2092	03/19/96
CT	4	THEODORE L. PESCE	(203)594-2090	03/19/96
CT	1	WILLIAM A. DUFF	(203)594-2091	08/26/94
DC	2	A.R. SLEEMI	(202)939-8098	03/13/89
DC	2	A.R. SLEEMI	(202)939-8098	03/13/89
DE	4	DAVID W. MATSEN	(302)739-4462	08/26/94
DE	1	JAMES C. HO	(302)739-3304	03/19/96
DE	2	JAMES C. HO	(302)739-3304	03/19/96
DE	3	JAMES C. HO	(302)739-3304	03/19/96

Traffic Monitoring Equipment Contacts
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State	Type	Name	Telephone	Updated
FL	1	J. MULDER BROWN	(904)488-4111	03/20/96
FL	2	J. MULDER BROWN	(904)488-4111	03/20/96
FL	3	J. MULDER BROWN	(904)488-4111	03/20/96
FL	4	J. MULDER BROWN	(904)488-4111	03/20/96
GA	2	SCOTT KNIGHT	(404)986-1367	09/08/94
GA	3	SCOTT KNIGHT	(404)986-1367	09/08/94
GA	4	SCOTT KNIGHT	(404)986-1367	09/08/94
HI	1	KENNETH MIYAZONO	(808)587-1838	08/25/94
HI	2	KENNETH MIYAZONO	(808)587-1838	08/25/94
HI	4	KENNETH MIYAZONO	(808)587-1838	08/25/94
IA	1	DONALD G. MILLER	(515)239-1046	03/20/96
IA	2	DONALD G. MILLER	(515)239-1046	03/20/96
IA	3	DONALD G. MILLER	(515)239-1046	03/20/96
IA	4	DONALD G. MILLER	(515)239-1046	03/20/96
ID	2	JOANN AUGER	(208)334-8213	03/20/96
ID	3	RAELENE VISTE	(208)334-8218	03/20/96
ID	4	SCOTT W. FUGIT	(208)334-8207	03/20/96
IL	1	ROBERT GREEN	(217)785-2355	03/20/96
IL	2	ROBERT GREEN	(217)785-2355	03/20/96
IL	3	ROBERT GREEN	(217)785-2355	03/20/96
IL	4	ROBERT GREEN	(217)785-2355	03/20/96
IN	1	DAVID L. COCHRAN	(317)494-2213	03/20/96
IN	2	HENRY RHEE	(317)233-1166	03/20/96
IN	3	HENRY RHEE	(317)233-1166	03/20/96
IN	4	HENRY RHEE	(317)233-1166	03/20/96
KS	4	GARRY OLSON	(913)296-3841	08/26/94
KS	3	PAUL BARRY	(913)296-3841	08/26/94
KS	1	WILLIAM HUGHES	(913)296-3841	03/20/96
KS	2	WILLIAM HUGHES	(913)296-3841	03/20/96
KS	3	WILLIAM HUGHES	(913)296-3841	03/20/96
KS	4	WILLIAM HUGHES	(913)296-3841	03/20/96
KY	4	DAN INABNITT	(502)564-7183	03/20/96
KY	4	JOE CRABTREE	(502)564-7183	03/20/96
KY	2	ROB BOSTROM	(502)564-7183	03/20/96
KY	3	ROB BOSTROM	(502)564-7183	03/20/96
KY	4	ROB BOSTROM	(502)564-7183	03/20/96
KY	1	ROBERT IRISH	(502)564-3020	08/31/94
LA	1	EDWARD M. WAGNER, JR.	(504)358-9104	03/20/96
LA	2	EDWARD M. WAGNER, JR.	(504)358-9104	09/28/94
LA	3	EDWARD M. WAGNER, JR.	(504)358-9104	09/28/94
LA	4	EDWARD M. WAGNER, JR.	(504)358-9104	09/28/94
MA	1	PHILIP A. HUGHES	(617)973-7330	03/27/96
MA	2	PHILIP A. HUGHES	(617)973-7330	03/27/96
MA	3	PHILIP A. HUGHES	(617)973-7330	03/27/96
MA	4	PHILIP A. HUGHES	(617)973-7330	03/27/96
MD	1	LES VICKERS	(410)787-4050	11/21/92
MD	2	LES VICKERS	(410)787-4050	11/21/92
MD	3	LES VICKERS	(410)787-4050	11/21/92

Traffic Monitoring Equipment Contacts
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State	Type	Name	Telephone	Updated
ME	1	DAVID T. ROPER	(207)289-2035	03/27/96
ME	2	DAVID T. ROPER	(207)289-2035	03/27/96
ME	3	DAVID T. ROPER	(207)289-2035	03/27/96
ME	4	DAVID T. ROPER	(207)289-2035	09/28/94
MI	1	DARRELL CAMPBELL	(517)322-1716	03/20/96
MI	2	DARRELL CAMPBELL	(517)322-1716	03/20/96
MI	3	DARRELL CAMPBELL	(517)322-1716	03/20/96
MI	4	DARRELL CAMPBELL	(517)322-1716	03/20/96
MN	4	MARK NOVAK	(612)296-2607	03/20/96
MN	2	ORV ROBINSON	(612)725-2326	03/20/96
MN	1	RODNEY HEUER	(612)296-1678	03/20/96
MN	2	RODNEY HEUER	(612)296-1678	03/20/96
MN	3	RODNEY HEUER	(612)296-1678	03/20/96
MO	1	ALLAN HECKMAN	(314)751-2842	08/26/94
MO	2	ALLAN HECKMAN	(314)751-2842	08/26/94
MO	3	ALLAN HECKMAN	(314)751-2842	08/26/94
MO	4	ALLAN HECKMAN	(314)751-2842	08/26/94
MS	1	CLARENCE MELTON	(601)359-7685	03/20/96
MS	2	CLARENCE MELTON	(601)359-7685	03/20/96
MS	3	CLARENCE MELTON	(601)359-7685	03/20/96
MS	4	CLARENCE MELTON	(601)359-7685	03/20/96
MT	1	DENNIS A. HULT	(406)444-6122	09/28/94
MT	2	DENNIS A. HULT	(406)444-6122	09/28/94
MT	3	DENNIS A. HULT	(406)444-6122	09/28/94
MT	4	DENNIS A. HULT	(406)444-6122	09/28/94
NC	1	DAVID G. WHITE	(919)733-9770	08/26/94
NC	2	DAVID G. WHITE	(919)733-9770	08/26/94
NC	3	DAVID G. WHITE	(919)733-9770	08/26/94
NC	4	DAVID G. WHITE	(919)733-9770	08/26/94
ND	1	BOB SPECKMANN	(701)224-4401	10/26/94
ND	2	BOB SPECKMANN	(701)224-4401	10/26/94
ND	3	BOB SPECKMANN	(701)224-4401	10/26/94
ND	4	BOB SPECKMANN	(701)224-4401	10/26/94
NE	1	CARL HUMPHREY	(402)479-4594	08/31/94
NE	2	TERRY L. GUY	(402)479-4509	03/20/96
NE	3	TERRY L. GUY	(402)479-4509	03/20/96
NE	4	TERRY L. GUY	(402)479-4509	03/20/96
NH	1	MS. NASTARAN SAADATMAND	(603)271-1623	03/23/96
NH	2	MS. NASTARAN SAADATMAND	(603)271-1623	03/23/96
NH	3	MS. NASTARAN SAADATMAND	(603)271-1623	03/23/96
NH	4	MS. NASTARAN SAADATMAND	(603)271-1623	03/23/96
NJ	2	ROBERT BOUSENBERRY	(609)530-3513	08/26/94
NJ	3	ROBERT BOUSENBERRY	(609)530-3513	08/26/94
NJ	1	STEPHEN DECKER	(609)530-3528	08/26/94
NJ	4	STEPHEN DECKER	(609)530-3528	08/26/94
NM	4	BILL LARRANAGA	(505)827-5381	03/23/96
NM	3	ERNIE VIGIL	(505)827-5382	03/23/96
NM	4	ERNIE VIGIL	(505)827-5382	03/23/96

Traffic Monitoring Equipment Contacts
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State	Type	Name	Telephone	Updated
NM	1	JOHN M. VIGIL	(505)827-5382	03/23/96
NM	2	JOHN M. VIGIL	(505)827-5382	03/23/96
NV	3	CECIL CRANDALL	(702)687-5620	03/20/96
NV	2	DAN RICE	(702)687-5620	03/20/96
NV	3	DAN RICE	(702)687-5620	03/20/96
NV	4	JAMES ORSBERN	(702)687-3455	03/20/96
NV	1	MICHAEL QUINTERO	(702)687-3453	03/20/96
NV	2	MICHAEL QUINTERO	(702)687-3453	03/20/96
NY	1	DAVID FIFIELD	(518)457-2815	09/08/94
NY	3	DAVID FIFIELD	(518)457-2815	09/08/94
NY	2	DAYTON J. BURLARLEY	(518)451-7203	03/23/96
NY	4	DAYTON J. BURLARLEY	(518)451-7203	03/23/96
OH	4	ANDREW WILLIAMS	(614)466-4224	03/23/96
OH	1	TONY MANCH	(614)466-3075	03/23/96
OH	2	TONY MANCH	(614)466-3075	03/23/96
OH	3	TONY MANCH	(614)466-3075	03/23/96
OK	4	JON MITCHELL	(405)521-2575	03/23/96
OK	3	LESTER HARRAGAMA	(405)521-2575	03/23/96
OK	2	MIKE WOODHAMS	(405)521-2575	03/23/96
OK	1	TONY VAUGHAN	(405)521-4476	11/22/92
OR	3	H. MARTIN LAYLOR	(503)986-2850	03/23/96
OR	4	KEN EVERT	(503)945-7938	03/23/96
OR	1	STEVE REED	(503)986-3608	03/23/96
OR	2	TIM H. THEX	(503)986-4132	03/23/96
OR	3	TIM H. THEX	(503)986-4132	03/23/96
PA	1	TOM REINDOLLAR	(717)787-2187	03/23/96
PA	2	TOM REINDOLLAR	(717)787-2187	03/23/96
PA	3	TOM REINDOLLAR	(717)787-2187	03/23/96
PA	4	TOM REINDOLLAR	(717)787-6322	03/23/96
RI	4	MICHAEL SPRAGUE	(401)277-2694	08/25/94
RI	1	PAUL O. McENANLY	(401)277-2694	08/25/94
RI	2	PAUL O. McENANLY	(401)277-2694	08/25/94
RI	3	PAUL O. McENANLY	(401)277-2694	08/25/94
SC	1	BOB MANGER	(803)737-1444	03/23/96
SC	2	BOB MANGER	(803)737-1444	03/23/96
SC	4	BOB MANGER	(803)737-1444	03/23/96
SC	4	CAPT. G. N. PAUL, SR.	(803)731-1437	03/23/96
SC	3	JOE BOOZER	(803)737-1118	03/23/96
SD	4	DAN STRAND	(605)773-3871	08/31/94
SD	1	JOHN NOYES	(605)773-3278	08/31/94
SD	2	JOHN NOYES	(605)773-3278	08/31/94
SD	3	JOHN NOYES	(605)773-3278	08/31/94
TN	1	RAY BARTON	(615)741-2070	03/25/96
TN	2	RAY BARTON	(615)741-2070	03/25/96
TN	3	RAY BARTON	(615)741-2070	03/25/96
TN	4	RAY BARTON	(615)741-2070	03/25/96
TX	1	STEVE SIMMONS	(512)467-3940	03/25/96
TX	3	STEVE SIMMONS	(512)467-3940	03/25/96
TX	4	STEVE SIMMONS	(512)467-3940	03/25/96
TX	2	WILL PEAVY	(512)465-7658	03/25/96

Traffic Monitoring Equipment Contacts
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State	Type	Name	Telephone	Updated
UT	1	TAMMY KAESER	(801)965-4137	03/25/96
UT	2	TAMMY KAESER	(801)965-4137	03/25/96
UT	3	TAMMY KAESER	(801)965-4137	03/25/96
UT	4	TAMMY KAESER	(801)965-4137	03/25/96
VA	2	BRYANT THORPE	(804)786-2956	03/25/96
VA	3	BRYANT THORPE	(804)786-2956	03/25/96
VA	3	G.C. CAMPBELL	(804)786-3971	03/25/96
VA	2	G.C.CAMPBELL	(804)786-3971	03/25/96
VA	4	JAMES G. BRADLEY	(804)786-3589	03/25/96
VA	1	ROBERT M. KRAY	(804)786-4567	03/25/96
VT	1	DAVID J. SCOTT	(802)828-2391	08/25/94
VT	2	DAVID J. SCOTT	(802)828-2391	08/25/94
VT	3	DAVID J. SCOTT	(802)828-2391	08/25/94
VT	4	DAVID J. SCOTT	(802)828-2391	08/25/94
WA	1	PAT McFAYDEN	(206)753-6156	03/25/96
WA	2	PAT McFAYDEN	(206)753-6156	03/25/96
WA	3	PAT McFAYDEN	(206)753-6156	03/25/96
WA	4	PAT McFAYDEN	(206)753-6156	03/25/96
WI	1	CAPT. ROBERT YOUNG	(608)267-2939	03/25/96
WI	4	CAPT. ROBERT YOUNG	(608)267-2939	03/25/96
WI	1	JOHN E. WILLIAMSON	(608)267-2939	08/26/94
WI	2	JOHN E. WILLIAMSON	(608)267-2939	08/26/94
WI	3	JOHN E. WILLIAMSON	(608)267-2939	08/26/94
WI	4	JOHN E. WILLIAMSON	(608)267-2939	08/26/94
WV	1	JERRY L. LEGG	(304)558-2864	03/25/96
WV	2	JERRY L. LEGG	(304)558-2864	03/25/96
WV	3	JERRY L. LEGG	(304)558-2864	03/25/96
WV	4	JERRY L. LEGG	(304)558-2864	03/25/96
WY	1	DAVE BIRGE	(307)777-4190	03/25/96
WY	2	DAVE BIRGE	(307)777-4190	03/25/96
WY	3	DAVE BIRGE	(307)777-4190	03/25/96
WY	4	KEVIN MESSMAN	(307)777-3944	03/25/96